Bruce B. Hostetler

PROCEEDINGS

OF THE TWENTY-FIFTH ANNUAL

WESTERN FOREST INSECT WORK CONFERENCE

Salt Lake City, Utah

March 5-7, 1974

Not for Publication

(For information of Conference Members only)

Prepared at

Rocky Mountain Forest and Range Experiment Station
U.S.D.A. - Forest Service
Fort Collins, Colorado 80521

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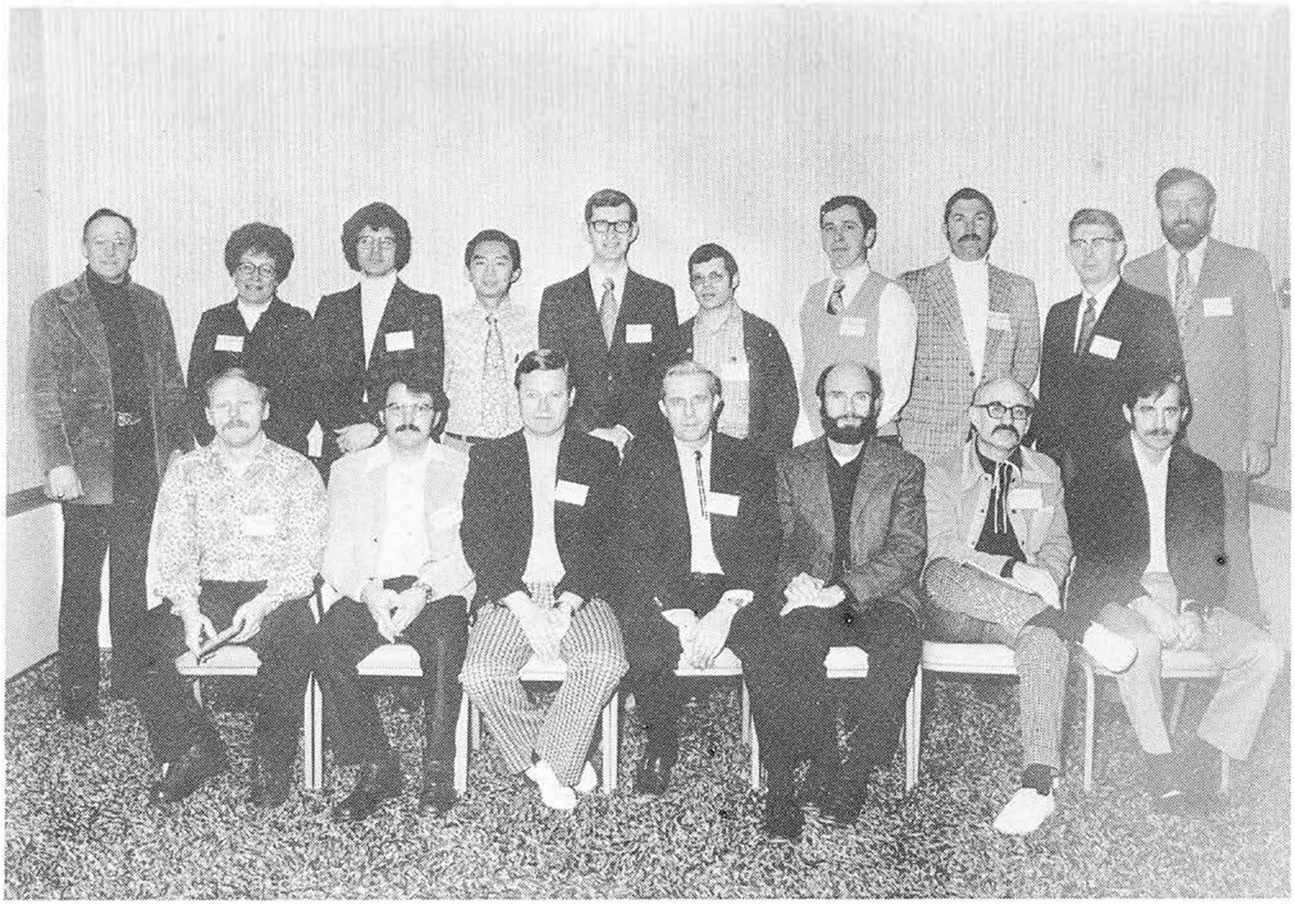
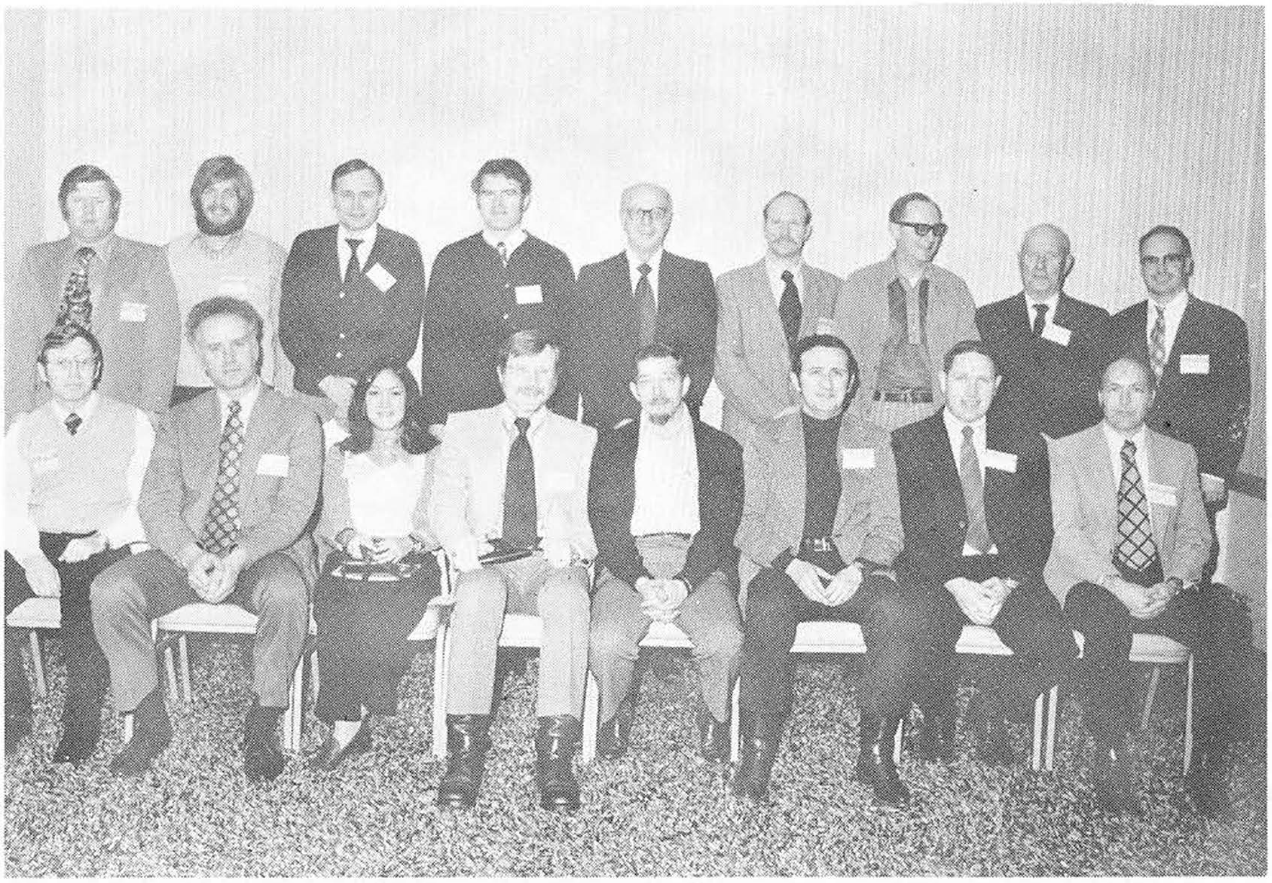


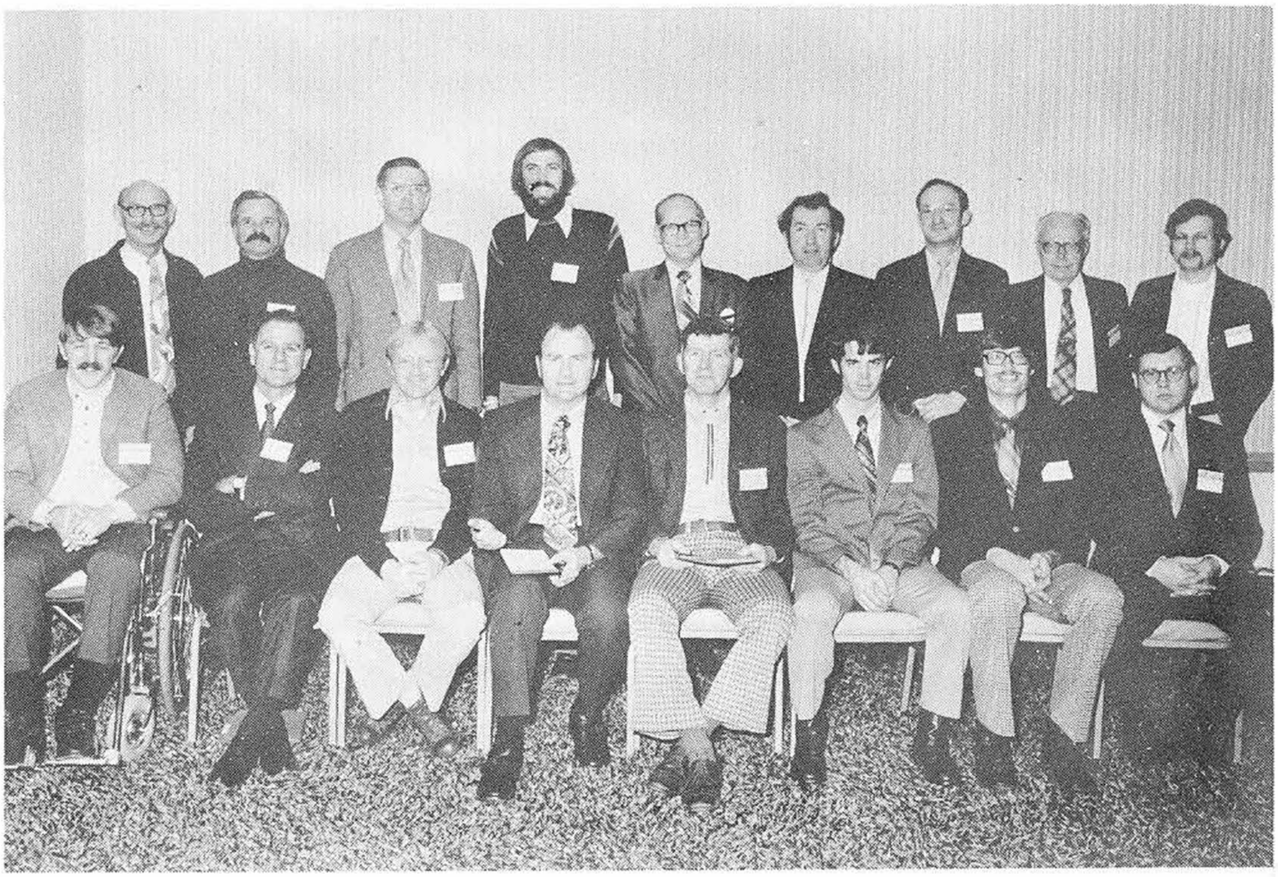
Back Row, L to R. J. Lowe, M. Moyer, L. Frandsen, N. Kirtibutr, B. Acciavatti, P. Gravelle, H. Osborne, G. Pitman, L. Morton, B. Klein.

Front Row, L to R. D. Kulhavy, B. Frye, M. Stelzer, R. Beckwith, G. Amman, R. Johnsey, L. Rasmussen.



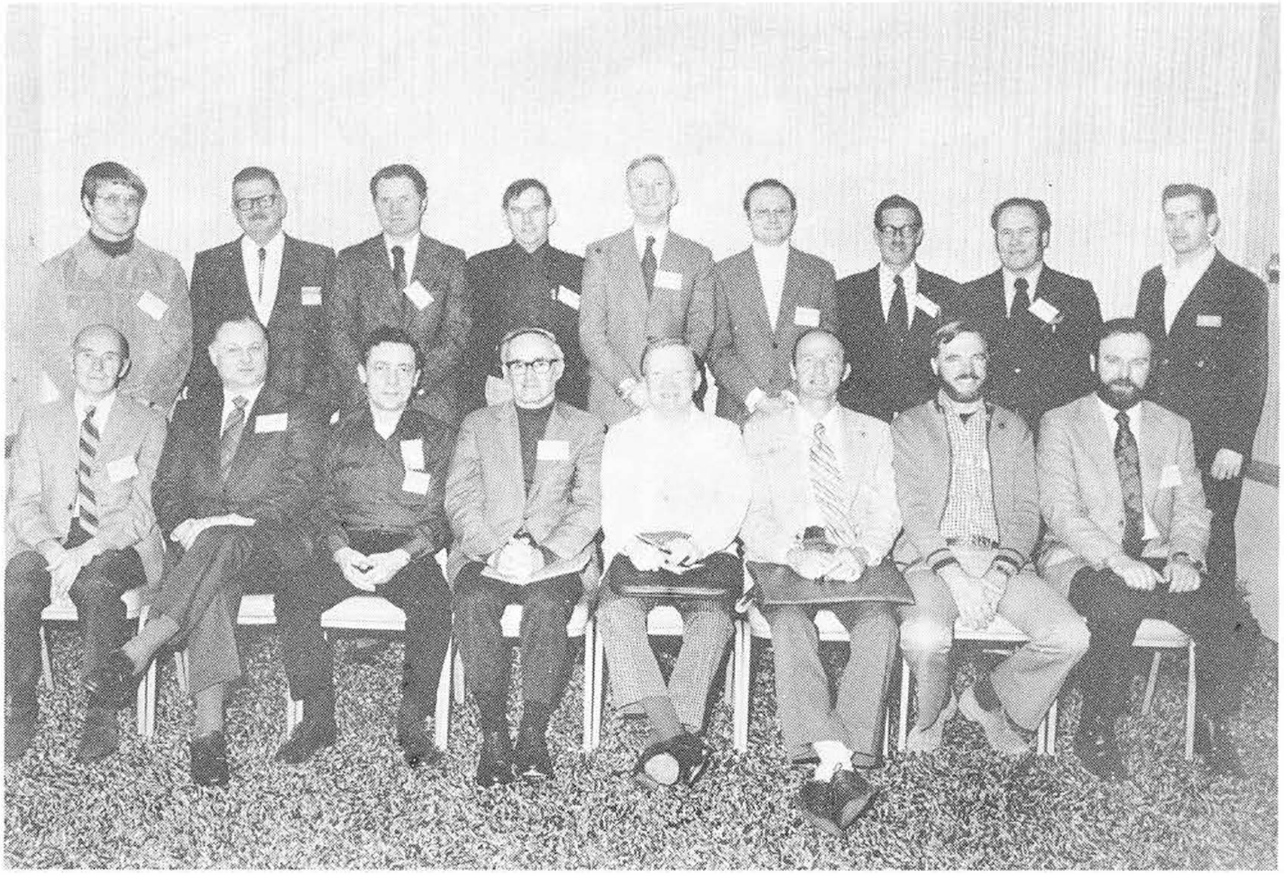
Back Row, L to R. K. Swain, B. Hostetler, L. Safranyik, M. Ollieu, B. Bailey, T. Torgersen, D. Washburn, L. Orr, W. Bousfield.

Front Row, L to R. W. Brewer, K. Stoszek, F. Stovall, B. Baker, W. Cole, M. McGregor, S. Kohler, F. Honing.



Back Row, L to R. G. Trostle, D. Cahill, S. Wood, N. Crookston, R. Harrison, J. Schmid, A. Rivas, E. Lampi, R. Clausen.

Front Row, L to R. C. Minnemeyer, R. Smith, B. Stevens, L. Browne, M. Furniss, D. Parker, G. Starr, L. Stipe.



Back Row, L to R. H. Flake, B. Denton, E. Michalson, J. Laut,
D. Dyer, L. Kline, H. Tripp, B. Ives, J. Stein.

Front Row, L to R. B. Wilford. B. Maksymiuk, J. Schenk,
B. McCambridge, D. McComb, B. Lyon, B. Wickman, C. Richmond.

PROCEEDINGS
of the Twenty-fifth Annual
WESTERN FOREST INSECT WORK CONFERENCE
Salt Lake City, Utah
March 5-7, 1974

EXECUTIVE COMMITTEE (Twenty-fifth Conference)

R. E. Stevens, Fort Collins	Chairman
D. L. Wood, Berkeley	Immediate Past Chairman
J. M. Schmid, Fort Collins	Secretary-Treasurer
B. E. Wickman, Corvallis	Councilor (1971)
W. G. H. Ives, Edmonton	Councilor (1972)
R. G. Cox, Lewiston	Councilor (1973)

D. L. Parker, Ogden	Program Chairman

EXECUTIVE COMMITTEE ELECT

G. C. Trostle, Boise	Chairman
R. E. Stevens, Fort Collins	Immediate Past Chairman
G. D. Amman, Ogden	Secretary-Treasurer
W. G. H. Ives, Edmonton	Councilor (1972)
R. G. Cox, Lewiston	Councilor (1973)
L. Safranyik, Victoria	Councilor (1974)

K. M. Swain, San Francisco	Program Chairman

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*Paper not submitted

PROGRAM

TWENTY-FIFTH ANNUAL WESTERN FOREST INSECT WORK CONFERENCE
ROYAL INN HOTEL, SALT LAKE CITY, UTAH
March 5-7, 1974

<u>Monday, March 4</u>

4:00 p.m. - 8:00 p.m.	Registration
8:00 p.m. Jewel Room	Executive Committee Meeting

<u>Tuesday, March 5</u>

8:00 a.m. - 9:00 a.m.	Registration
9:00 a.m. - 10:00 a.m. Royal Room	Initial Business Meeting
10:00 a.m. - 10:20 a.m.	Break
10:20 a.m. - 11:30 a.m. Royal Room	Solar-Terrestrial Relationships Speaker: R. Gilbert Moore, Astro Met. Div., Thyacol Chemical Co.
11:30 a.m. - 1:00 p.m.	Lunch
1:00 p.m. - 3:00 p.m. Royal Room	<u>Panel:</u> Should DDT Be Used For Control of Forest Defoliators? Moderator: David Dyer, Canadian Forestry Service, Victoria, British Columbia Panelists: For: Glen Parsons, Boise Cascade Corporation, LaGrande, Oregon E. E. Patterson, State Representative, Oregon State Legislature Against: Steven Herman, The Evergreen State College, Olympia, Wa. Richard Porter, Cooperator, Dept. of Interior, Provo, Utah
3:00 p.m. - 3:20 p.m.	Break
3:20 p.m. - 5:00 p.m.	<u>Concurrent Workshops:</u>
Jewel Room	1. Testing Spray Systems Moderator: Lynn Marsalis

Sundance Room	2. Cost-benefit Evaluations Moderator: Alfred Rivas, U.S. Forest Service, Ogden, Utah
Kings Room	3. Informing the Public about Forest Entomology Moderator: Wayne Brewer, Dept. of Zoology & Entomology, Colorado State University, Fort Collins, Colo.
Queens Room	4. What are the Bark Beetle Research Needs from the Standpoint of Control? Moderator: William McCambridge, Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.
7:00 p.m.	Banquet

<u>Wednesday, March 6</u>

8:30 a.m. - 10:00 a.m. Royal Room	Termites and Wood-destroying Beetles--Problems and Research Speaker: Richard Smythe, Southern Forest Experiment Station, Gulfport, Miss. History of the WFIWC Speaker: Richard Washburn, Intermt. For. and Range Exp. Stn., Moscow, Idaho
10:00 a.m. - 10:20 a.m.	Break
10:20 a.m. - 12:00 Noon	<u>Concurrent Workshops:</u>
Jewel Room	1. Cooperative Pest Control Programs with States Moderator: Richard Johnsey, Dept. of Natural Resources, Olympia, Wa.
Sundance Room	2. New Information on the Biology and Control of the Douglas-fir Tussock Moth Moderator: Galen Trostle, U.S. Forest Service, Boise, Idaho
Kings Room	3. Use of pheromones Moderator: Gary Pitman, Boyce Thompson Institute, Grass Valley, Ca.

Queens Room	4. Assessing Host Resistance and Susceptibility to attack by Bark Beetles Moderator: Richard Smith, Pacific SW For. and Range Exp. Stn., Berkeley, Ca.
12:00 - 1:00 p.m.	Lunch
1:00 p.m.	Tour

Thursday, March 7

8:30 a.m. - 10:00 a.m. Royal Room	Pesticides and Environmental Law Speaker: Dean Gardner, Office of the General Council, Ogden, Utah
10:00 a.m. - 10:20 a.m.	Break
10:20 a.m. - 11:30 a.m. Royal Room	Final Business Meeting
11:30 a.m. - 1:00 p.m.	Lunch
1:00 p.m. - 3:00 p.m.	Concurrent Workshops:
Jewel Room	1. Insect-host Relationships Moderator: Les Safranyik, Canadian Forestry Service, Victoria, British Columbia
Sundance Room	2. Programable Calculators Moderator: Robert Acciavatti, U.S. Forest Service, Albuquerque, N.M.
Kings Room	3. Estimating Damage caused by Forest Insects Moderator: Lawrence Stipe, U.S. Forest Service, Ogden, Utah
Queens Room	4. Enhancing Career Opportunities for Technicians Moderator: George Starr, U.S. Forest Service, Boise, Idaho.

MINUTES OF EXECUTIVE COMMITTEE MEETING
March 4, 1974

The Executive Committee was called to order by Chairman R. E. Stevens at 8:10 p.m. in the Jewel Room, Royal Inn, Salt Lake City.

Present were B. Wilford, D. Parker, B. Wickman, B. Ives, R. Cox, and J. Schmid.

Status of the 1971 and 1972 WFIWC Proceedings were discussed. Stevens said their status remained the same. Parker suggested that a time limit for their publication be set. Stevens agreed to discuss a time limit with Koerber and if he could not meet a designated time limit, the files for the 1971 and 1972 proceedings were to be forwarded to the current secretary.

Minor changes in the 1974 program were discussed. Parker indicated three changes: (1) a change in one of the workshops, (2) a change in the fee schedule--$5.00 for regular members, $1.00 for students, and (3) greetings from city officials were deleted from the program.

Ives suggested that there may be some confusion amongst new members as to who is chairman of what. Stevens agreed to explain the conference organization in the initial business meeting.

McKnight, through Parker, suggested that the chairman of the common names committee present the mission of their committee. Ives agreed to discuss the role of this committee in the initial business meeting.

The location of the 1976 meeting was discussed. Invitations were received from the Moscow, Idaho and Portland, Oregon areas. Wickman and Cox were appointed to resolve the location question.

A nominating committee for the next slate of officers was discussed. A committee was established subject to their acceptance to serve.

The membership list was discussed. Wilford noted that many retirees were not on the list in the proceedings and that such retirees would like to receive notice of the annual meetings. Wilford agreed to discuss the creation of a special mailing list in the final business meeting.

There being no other business the meeting was adjourned at 9:25 p.m.

MINUTES OF INITIAL BUSINESS MEETING
March 5, 1974

Meeting called to order at 9:15 a.m. in the Royal Room of the Royal Inn in Salt Lake City, Utah, by Chairman Stevens.

Retirees and new members were introduced. One of our pioneer members, Les Orr, was recognized.

Chairman Stevens explained the WFIWC organizational structure.

Minutes of the 1973 final business meeting were read. Washburn requested that reference to his name as a substitute member of the ethical practices committee be deleted. Minutes were approved as modified.

The treasurer reported $1,097.73 on hand at the beginning of the meeting.

Minutes of the executive committee were read.

The chairman of the ethical practices committee being absent, W. Cole was appointed interim chairman.

Chairman of the common names committee, Bill Ives, scheduled a meeting of the committee at 5:00 p.m. in the Jewel Room.

The joint meeting of the WFIWC and WIFDWC in 1975 was briefly discussed although detailed discussion was tabled until the final business meeting.

The 1976 WFIWC was discussed. Boyd Wickman presented the attributes of the Portland area and Dick Washburn presented the attributes of the Moscow area.

The status of the 1971-72 proceedings was questioned. Since the executive committee decided that the 1971-72 proceedings should be sent from Koerber to the current secretary for assembly, the discussion was terminated.

A committee consisting of Dave Dyer, Rick Johnsey and Walt Cole was appointed to select the officers for the next 2 years.

Dave Dyer sadly reported that John Chapman has leukemia but his condition has stabilized.

Program Chairman Parker made announcements concerning the conference. In particular he discussed:

1. Daterman was to be replaced by Pitman as moderator in the "Use of pheromones" workshop on Wednesday morning.

2. Coffee, etc. to be provided during breaks on second floor.

3. Conference photographs to be taken after the initial business meeting.

4. General directions for finding the meeting rooms.

5. Banquet.

6. Registration for late arrivals.

7. Arrangements for the ski trip.

There being no other business, the meeting was adjourned at 9:50 a.m.

PANEL: SHOULD D.D.T. BE USED FOR CONTROL OF FOREST DEFOLIATORS?

Moderator: E. D. A. Dyer

Panelists: Glenn B. Parsons (For)
E. E. Patterson (For)
Steven C. Herman (Against)
Richard Porter (Against)

Introduction: E. D. A. Dyer

The subject of our panel discussion cannot be viewed from the limited outlook of control of defoliators alone but rather considered in the wider context of planning and protection of the environment. Nearly all of us have some influence over the course of events leading to the way in which the environment is managed and protected for the greatest benefit. Today we have an opportunity to learn from the experience of others and to bring out all aspects relevant to forest protection and ecological well being.

We are very grateful to these gentlemen who have taken time from very busy schedules to give us their knowledge and insight into pressing problems of environmental and resource management. We should all recognize and expect that some aspects of management strike different people in different ways depending upon their values and points of view. Therefore we should take a multi-disciplinary approach and weigh both parts of the dilemma--the forest health and the health of the total environment.

Statement: Glenn B. Parsons

I am Glenn B. Parsons, Chief Forester, Northeast Oregon Region, Boise Cascade Corporation, LaGrande, Oregon. I am an Oregon State University forestry graduate with 17 years of experience with the U.S. Forest Service and 22 years of experience with Boise Cascade Corporation and its predecessors, all of which have been spent in Northeast Oregon forests.

My residence is Summerville, Oregon. I live within one mile of the timbered slope north of Mt. Emily which has been heavily damaged by the Douglas-fir tussock moth (*Orgyia pseudotsugata*).

The Beginning

June 25, 1972 was the beginning of the Blue Mountain infestation which is part of the most destructive and largest forest insect

epidemic in history in the West. Within a five-day period, we observed our Douglas-fir and white fir forests changing color from a healthy green to a sickly brown. Within a few days the 1972 tussock moth epidemic extended 75 miles north from LaGrande, Oregon to Dayton, Washington wheat fields.

Boise Cascade tried to obtain approval to use effective chemical control during June, 1972 but the only available material in the State's chemical arsenal was Malathion. We were advised that Malathion was ineffective against the tussock moth.

1973 Decisions

Soon after the 1972 tussock moth feeding had terminated the 1972 tussock moth aerial survey was completed. It revealed that 173,600 acres of visible defoliation occurred in the Blue Mountains and 23,210 acres occurred in Northern Washington. The two-state total of 196,810 acres was 31% privately owned (1972 map).

Mr. William D. Ruckelshaus, Administrator, Environmental Protection Agency, in his April 20, 1973 letter to Mr. Robert W. Long, Assistant Secretary of Agriculture, denied the Department of Agriculture's request to use DDT. Instead, they suggested an alternative for the U.S. Forest Service to formulate an action plan based on the use of available chemical methods, other than DDT, that could be put into operation on an immediate emergency basis.

The decision for the Forest Service to formulate a plan based on the "use of available chemical methods, other than DDT," was not based upon sound scientific data. Mr. Ruckelshaus recommended using chemicals that had not gone through the complete research and development stages.

The April 1973 Environmental Statement, page 2, said, "Although the Environmental Protection Agency indicates that chemicals other than DDT could be used to control this outbreak, there are none that are either proven effective or registered for this purpose."

On page 3, the EIS states, "Based upon laboratory tests by topical application Zectran is about one-half as toxic as DDT to the Douglas-fir tussock moth...Zectran showed little residual insecticide activity after 48 hours exposure in an outdoor environment. The chemical is not likely to be toxic to tussock moth larvae which hatch 2 or more days after spray application, thus two sprays would be needed."

"...past experience has also shown that for Douglas-fir tussock moth outbreaks a population reduction of close to 100 percent must be achieved to prevent damage to host trees."

Operational Test with Zectran

Because of the above decisions, the Forest Service conducted an expanded operational test of the chemical Zectran on 69,496 Blue Mountain acres on private land and on public land in the Walla Walla watershed.

Boise Cascade Corporation entered into a "Landowner Agreement" to conduct an operation test of Zectran, using two applications based upon our priority selection and using a prudent time schedule, on 31,000 acres of forest land.

This acreage figure represented about 50% of our 1972 infestation area. In designating our priority system we decided to sacrifice certain areas with mature trees to save a maximum of fir reproduction and immature timber. In a further effort to expand this control operation we gathered egg mass samples from several areas to determine if the virus would be an effective ally. The highest virus incidence was 1.35% which rapidly declined to 0.00% and it was inadequate for effective control. Later we made two requests for additional chemical spraying when it became evident that our 1973 damage was going to be severe. These requests were denied because EPA would not permit more than 70,000 acres of operational tests with Zectran.

Zectran proved ineffective...it killed some bugs but it did not materially reduce the damage to our forests. On August 9, we flew Assistant Secretary of Agriculture Robert Long, via helicopter, up Phillips Creek near Elgin, Oregon. I informed Secretary Long that the private land on the east side of Phillips Creek received two applications of Zectran, and the Forest Service land on the west side didn't receive any. He quickly compared the appearance of both areas and said, "What is the difference?"

The tussock moth damage ranges from light to almost total destruction to the affected fir forests. This forest insect has materially damaged aesthetic values of homes and mountain cabins; it killed approximately 79,340 acres of mature and immature commercial forests in Oregon and Washington; it damaged or killed millions of young fir trees and the cone bearing portion of the white fir trees on 275,660 Class II acres; it damaged watersheds, wildlife habitats and fisheries; it will substantially increase fire protection costs for many years; it has weakened trees which are prime targets to subsequent bark beetle attacks; and it will cost millions of dollars to restore the damaged forest. This loss and damage will affect the economics, taxes, and jobs of the related areas for many years.

Results of Chemical Tests

On September 25, 1973, the Inter-Agency Tussock Moth Steering Committee, made up of representatives of the Forest Service,

Forestry Departments of Oregon, Washington and Idaho, the Bureau of Indian Affairs, and Oregon State University's School of Forestry, reviewed the results of the tests of the insecticides Zectran, Dylox, Seven 4-Oil, and Bioethanomethrin. The committee reports: "Results of the tests in Oregon and Washington show that all the chemicals killed considerable numbers of tussock moth larvae, but none reduced the population sufficiently to prevent severe defoliation and tree mortality."

"A virus and bacterium were also tested against the tussock moth. According to the committee report, both of these were highly effective in killing the moth and reducing defoliation. However, neither of these microbial agents is available in sufficient quantity for use next year and there are many difficulties in application that must be solved before either can be used on a large scale."

Dr. Clarence G. Thompson, Principal Entomologist, Forestry Sciences Laboratory, Corvallis, Oregon in an August 29, 1973 letter to me said, "As regards your query concerning the availability of the tussock moth virus, we have on hand enough virus to treat about 7,000 acres. In the relatively short time available, industry might produce enough to treat another 30,000 acres. Our plan has been to go through the R & D stages with the virus now on hand. We have gone through the lab test and field stages and the next step is the pilot control test. While our results this year have been very good, I do not favor leap-frogging over the pilot control test directly to operational use. Sound R & D practices include the pilot control test as a vital part of testing before general use is recommended. In addition, the acreage that could be treated next year would be limited to the amount of virus that could be available."

1974 Decisions

The 1974 public and private forestry job priority list includes the following:

1. Terminate the Douglas-fir tussock moth epidemic.

2. Protect the damaged areas from fire and subsequent bark beetle epidemics.

3. Initiate reforesting the dead and severely damaged areas.

The 1973 "draft" environmental statement states on page 19, "The largest outbreak, encompassing 629,500 acres and including 69,890 acres of heavy tree mortality, occurred in the Blue Mountains." This represents an acreage increase of 3.6 times during 1973 (see map)... On page 31 the EIS states, "Most of the immature trees in Class I and Class II defoliation areas died."

During 1973, in addition to causing an estimated 1,220.8 mbf of mortality and growth loss valued at $77.1 million, the tussock moth did extensive damage to other resources.

Data collected during insect egg survey in the fall of 1973 indicated that significant tussock moth populations were distributed over 381,000 acres of forest land in the Blue Mountains...and it is predicted that the tussock moth population will cause serious defoliation and tree killing on 194,000 of host-type in the Blue Mountains...and on page 185, "natural collapse, if it does occur in the third year, usually does not take place until during the late stages of the insect development. Regardless whether the population collapses that year or not, the same amount of damage can occur...it is a very serious mistake to conclude that all infestations are in the same time-development phase. It simply cannot be considered as one large outbreak."

The tussock moth eggs are hatching in the Forest Service Research Laboratory in Portland. Soon an evaluation of the virus will be made. In my opinion, the virus incident will need to be heavy and widespread if we are to obtain effective, natural control without undue damage to our forests. The 1974 tussock moth infestation is scattered in large population islands surrounded by buffer zones in which most of the 1973 larvae starved. These buffer zones will preclude widespread population collapse this coming summer.

Here we are, Gentlemen, with 650,000 acres of tussock moth in Oregon, Washington and Idaho without effective chemical control, except DDT. Forest management has already been set back 30 to 50 years by past chemical control decisions. We are pleading for help in controlling this infestation in 1974. We do not choose to compound an already serious problem.

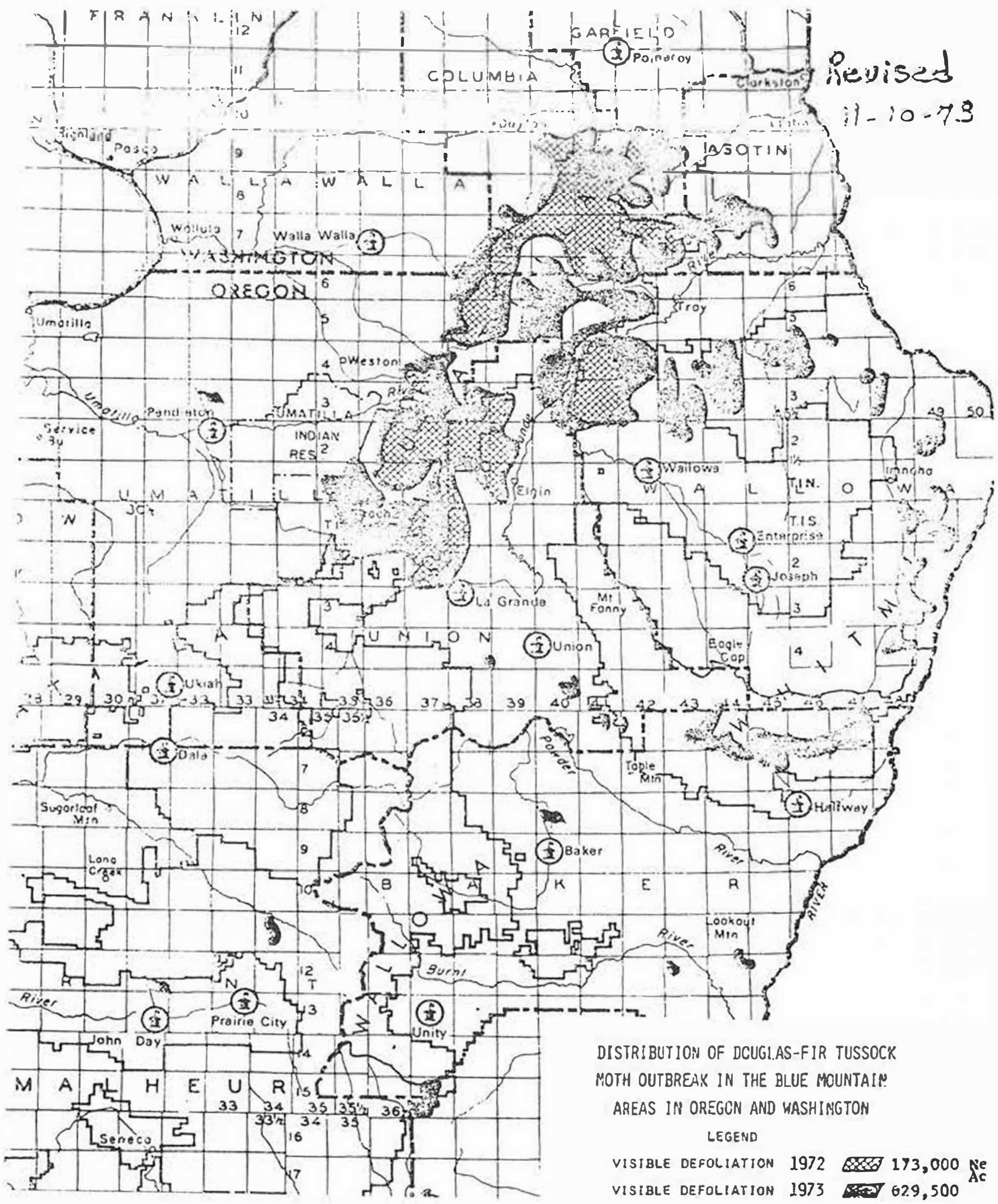
On February 26, 1974, Mr. Russell E. Train, Administrator, U.S. Environmental Protection Agency, made a statement in Seattle, Washington, relative to this problem. Mr. Train stated, "I have reached this decision reluctantly, and only after long and careful consideration of whether emergency conditions exist, and the availability of practical alternatives to DDT. After careful examination of all of the facts presented to me, I conclude that the potential for a serious emergency this summer is present, and that DDT is the most practical control available."

The people in the tussock moth damaged area congratulate Mr. Train upon his approval to use DDT on a contingency basis. It is most regrettable that EPA did not fully recognize this serious problem in 1973 when professional opinion strongly urged this action. We sincerely hope it won't be necessary to use DDT but after the bad experience last year we are very skeptical. We do not want the

tussock moth epidemic to continue expanding uncontrolled for another year with its severe damage to our forests.

The forest products industries has been accused of distorting the facts and exaggerating tree damage. I do not choose to continue debating these "distortions." As a result, I have submitted standing invitations for individuals or groups to inspect the tussock moth damage in the Blue Mountains. Inclement weather precludes making these visual inspections at this time. June and July will be the most appropriate months. As a result of these tours you will be in a position to make your own decision concerning the resultant damage.

Revised
11-10-73

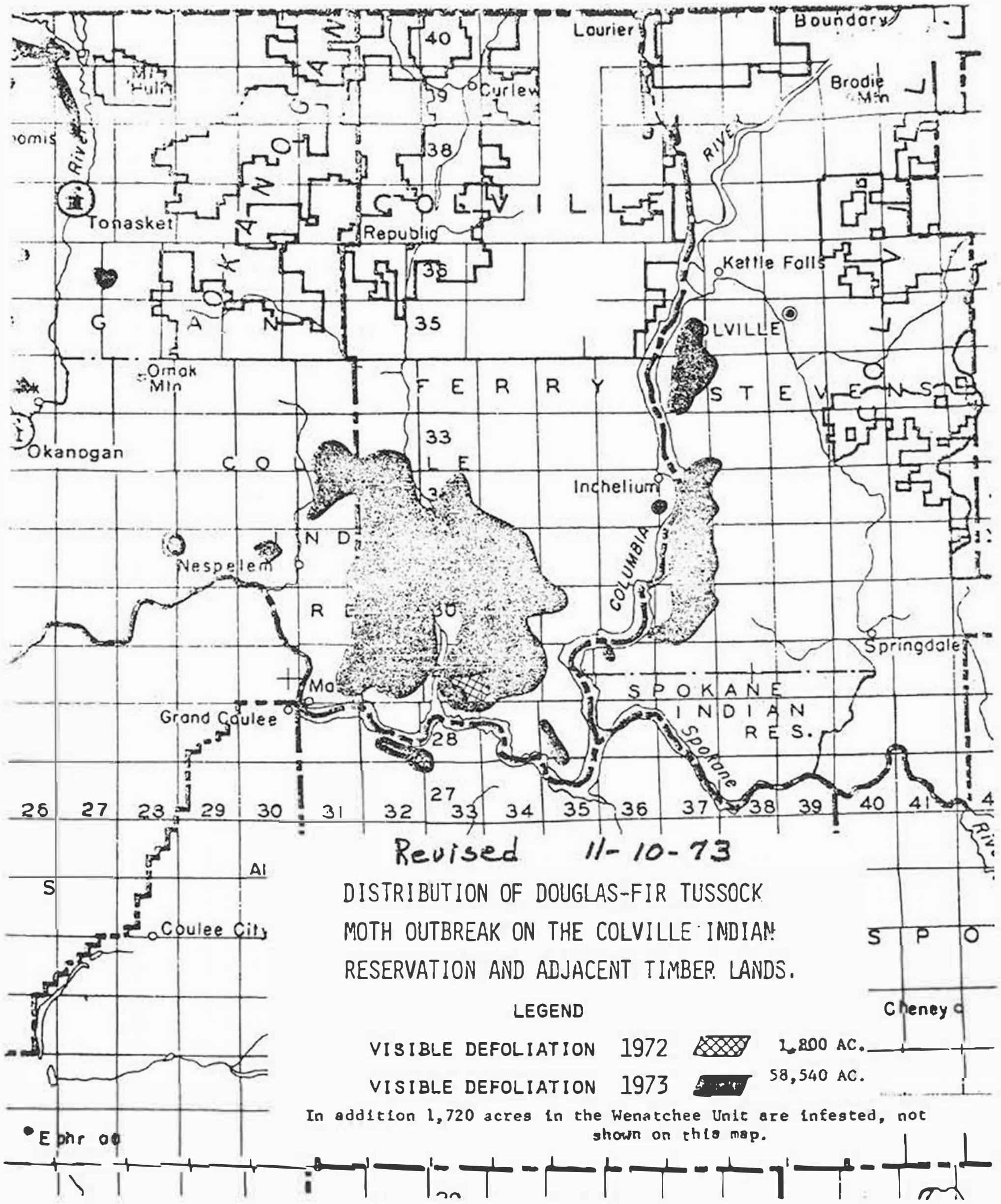


DISTRIBUTION OF DOUGLAS-FIR TUSSOCK MOTH OUTBREAK IN THE BLUE MOUNTAIN AREAS IN OREGON AND WASHINGTON

LEGEND

VISIBLE DEFOLIATION 1972 173,000 Ac

VISIBLE DEFOLIATION 1973 629,500



Laurier
Boundary
Brodie Mtn
40
Curlew
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Tonasket
Republic
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35
Kettle Falls
COLVILLE
OKANOGAN
FERRY
STEVENS
Omak Mtn
Okanogan
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Inchelium
Nespelem
COLUMBIA
Springdale
SPOKANE INDIAN RES.
Spokane
Grand Coulee
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26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41
Coulee City
Cheney
SPO
Ephrata
Revised 11-10-73
DISTRIBUTION OF DOUGLAS-FIR TUSSOCK
MOTH OUTBREAK ON THE COLVILLE INDIAN
RESERVATION AND ADJACENT TIMBER LANDS.
LEGEND
VISIBLE DEFOLIATION 1972 1,800 AC.
VISIBLE DEFOLIATION 1973 58,540 AC.
In addition 1,720 acres in the Wenatchee Unit are infested, not shown on this map.

Statement: E. E. "Ed" Patterson, State Representative
Oregon State Legislature

On April 20, 1973, William D. Ruckelshaus, Administrator for the Environmental Protection Agency, denied a request by various governmental and non-governmental agencies to lift the ban on DDT for use against the Douglas-fir tussock moth in northeast Oregon and southeast Washington.

That decision, based largely on unconfirmed allegations of the hazards, was the refusal to allow the ban to be lifted and the use of DDT was denied for controlling an infestation larger in acres than some states.

In making that decision, the fledgling Environmental Protection Agency earned a place in history. The question is, will William D. Ruckelshaus be remembered as a naive bureaucrat whose political expediency was responsible for the continuation of an epidemic that destroyed thousands of acres of forest lands?

Or will he be remembered as the man who saved the nation from the use of a dreaded chemical?

The answer, of course, is relatively simple, depending on who you are. If you are a member of the Sierra Club, or the Oregon Environmental Council, or the Environmental Defense Fund, Ruckelshaus, no doubt, is some form of a hero who made a decision he had to make. After all, it seemed to be an established fact that the infestation was due to collapse in 1973 due to the cyclic history of the tussock moth.

If, however, you are a resident of the infested area, Ruckelshaus probably seems more like an armchair tyrant who made his decision without the benefit of a thorough scientific investigation. The place where you live has been transposed into mountainsides of defoliated trees, forest land that once stood as a symbol to economic security and esthetic beauty has been transformed into a reddish-brown fire hazard and a symbol of governmental stupidity.

As a state representative coming from an area where a recent poll indicated 84% of the population favoring the use of DDT against the tussock moth, I would like to share with you some of the sentiments of those citizens who live in an area that has experienced the infestation of a forest pest of substantial magnitude.

Citizens of Northeast Oregon and others who have followed closely the developments of the tussock moth infestation are very much aware of the ramifications of the EPA decision in April of last year. At a period in our nation's history where the credibility of politicians and government in general is seriously threatened,

a federal agency deliberately overlooks the predicted destruction of our natural resources and denies the only effective tool that would prevent a natural disaster. In Northeast Oregon the infamous decision not to use DDT is comparable to the scandal of Watergate.

To quote Wallowa County Judge Claude Hall, "Seeing is believing, utter devastation. Economic and recreational opportunity being withdrawn for over 50 years. Shall we stop this holocaust with proven DDT or choose total destruction of the forest environment of the tussock moth? The choice should be obvious."

And Union County Judge, Earle Misener, "Revenue from timber sales helps pay for our roads and schools in Union County. I am seriously worried that the poor health of our timber lands will result in reduction of services to citizens of our community."

Or LaGrande businessman, Bob Burgess, "The majority of the citizens of the Grande Ronde Valley owe their living, one way or another, to the forest industry. Something as widespread as the tussock moth epidemic affects all of us. You don't have to work in the woods to feel this disaster."

Union County banker, Glenn Kirkeby, "It is pretty difficult to loan a man money on a stand of timber that no longer exists. That's what the tussock moth devastation has done to what had been the security of many citizens in Union and Wallowa Counties. I think it is a crime."

I believe that Ralph Peinecke, Manager of the Northeast Oregon Region of Boise Cascade Corporation, sums up the majority sentiment of the citizens of Northeast Oregon: "It is ironic that the Environmental Protection Agency, whose sole justification for existance is the protection of our environment, is wholly responsible for the magnitude of this environmental disaster. It could have been prevented, it wasn't. It should not be allowed to continue in 1974."

Over 500 small landowners have property infested by the tussock moth. A typical example is the property of Mrs. Adria Teske. She lives on about two acres just west of the city of LaGrande. She lives alone and is a working lady who lives out of town on her small acreage because she loves the great Oregon outdoors. The moths in their caterpillar stage totally enveloped her entire property. Her trees, her house, the ground outside her door, were covered with tussock caterpillars this past summer. Anyone with the slightest fetish about bugs would have moved from property so saturated with tussock moth larvae. The esthetic value of Mrs. Teske's property, as well as the monetary value of the property was substantially diminished after the summer of 1973.

Another example of the losses to small land owners is Mr. Jim Voelz. Because Jim is a small independent businessman in LaGrande and does not have the benefit of a retirement program, he purchased 600 acres of timber land on the Mount Emily slope of the Grande Ronde Valley. Jim looked forward to his retirement, and money that could have been used to purchase annuity programs was spent on this investment, and he looked forward to raising Christmas trees in his retirement years. Tussock moths hit Jim Voelz's property in 1972. He was one of the first small woodland owners who looked to the government for assistance in preventing the loss of his investment. Jim Voelz does not know what he will do in 1974, his timber has been wiped out, and he cannot afford a reforestation program, at $200 per acre, in his approaching retirement years. Is it any wonder that he speaks with bitterness in his voice about the unresponsiveness of government?

One of the least known aspects, and certainly one that is difficult to document, is the health hazards attributable to the tussock moth. Let me quote from a letter to the LaGrande Observer written by a distraught mother: "A week ago last Monday my son, Brian, age 9, got up with a rash on his face. I did not want to send him to school, not knowing what it was, so I took him to Dr. Haddock. I was told he had a virus from the tussock moth. My son's face is now starting to dry up. The rash had turned into large blisters. His face was very bad and itched terribly. Before it was over he had some on his arms and body. I was shocked to hear that the tussock moth could do that to people and my son hadn't even been in the forest. He was playing in his yard in leaves. I was raised with DDT in use for as long as I can remember and never had any ill effects from it. We have been in LaGrande one summer and my son gets sick from the tussock moth. Maybe you knew about the virus already, but I wanted to write in case you didn't. Dr. Haddock said a lot of people were coming down with it. Sincerely, Mrs. Arthur Mammott."

A lot of people have been affected by the moth. Most of them develop a rash, but some even develop ulcerated skin and bloody throats. The hairs shed by the moth as it grows during its larval stage are toxic, which causes real complications when salvage logging is practiced extensively. A lot of work hours were lost during the summer when loggers' allergenic reactions to the moth developed. The poison is so powerful that loggers' families reportedly developed rashes from clothes the loggers used to work in.

Because of the loss of time due to loggers' allergenic reactions, the Oregon Legislature passed a law exempting logging employers from workmen's compensation benefits being charged to their accounts. The tussock moth claims were jeopardizing their experience rating and increasing the cost of insurance.

Many loggers in the area have refused to work in tussock moth timber because of the serious health consequences.

I have talked with cattlemen and veterinarians who swear their cattle have died of respiratory diseases caused by the allergenic hairs of the tussock moths. But when I have asked for scientific documentation that the cause of death was due to tussock moth hairs, the obvious response from the cattleman is, "Hell, I can't prove it but every time I lose a cow it costs me about $400.00. Why should I pay to have the lung tissue sent to a pathologist in Salem. It has already cost me enough."

Hunters and game biologists report that wild game have left areas infested by the tussock moth. Loggers have reported the bodies of small animals in tussock moth infested timber. Although scientific proof is yet to be developed, the reports I have personally heard, lead me to believe there are serious health hazards associated with a tussock moth epidemic, both in human and animal life.

Sometime between noon and one p.m., August 16, 1973, a truck driver for a local logging company was driving on I 80N, near LaGrande, when he spotted a column of smoke rising from among some nearby tussock defoliated trees. The Oregon State Department of Forestry dispatched a small crew that fought the blaze which at that time was slightly over one acre in size.

Then it began to get windy. Before long, 30 to 40 mile an hour gusts were carrying flames through trees defoliated by the tussock moth. Within a few hours the fire had spread over thousands of acres posing a threat to the city of LaGrande, more than five miles away. For the better part of a week, some 1500 persons stood shoulder to shoulder with shovels, rakes, and gunny sacks, fighting the blaze while helicopters and airplanes dropped water and chemical retardant from the sky.

In the end nearly six thousand acres had burned, several fire fighters had been injured, wild animals burned, livestock were killed, and two residences and four summer cabins were left in cinders. Still, residents of Northeast Oregon were extremely lucky. If the fire had been allowed to take hold in the heavily defoliated tussock moth infested timber on the north side of I 80N, it could have increased the losses ten fold.

Citizens of Northeast Oregon are very cognizant of the tinder box at their front door step created by the tussock moth. As many foresters have indicated, only a miracle prevented the drought plagued forest from erupting into an explosive fire the likes of which we have not seen since the Tillamook burn in the 1930's.

The economic impact of Ruckelshaus's decision is no small item to citizens of Northeast Oregon. An estimated loss of 324 timber related jobs can be expected over the next few years. The local impact on private forest land alone could mean as much as eleven million dollars to the local economy.

The value of the projected loss in terms of mortality and growth is slightly over $6.3 million on private land alone. The dollar impact through growth loss alone is approximately $4 million on state and private lands. The estimated cost of re-establishing a new forest on state and private lands requiring rehabilitation is $1,395,000. The immediate impact of increased fire danger on tussock moth damaged lands is $530,900 for prevention, manpower and equipment. Defoliation and death of trees on lands in Northeast Oregon can reduce property values 25 to 50%.

The total economic impact that will accrue to private and state landownerships in terms of timber loss, growth loss, rehabilitation costs, increased fire protection costs and diminished land values is estimated to be $9,546,400 IF the infestation is halted before further damage is done.

And now, since the most recent EPA decision, there are those that are saying the Russell Train decision to allow the use of DDT on the tussock moth infestation was political. I do not believe this to be true! I believe it was a decision that was based on economics and the realization that in protecting our environment trade-offs must be made. That before banning undesirable chemical controls of pests, alternatives must be found. Perhaps the tussock moth epidemic will prove to be the catalyst that will return the decision making process to one based on scientific fact and away from the emotionalism of political expediency.

The Statements Against, by Steven C. Herman and Richard Porter were not submitted.

WORKSHOP: TESTING SPRAY SYSTEMS

Moderator: Lynn Marsalis

Operational and meteorological considerations relative to planning and conducting aerial spray tests with an introduction to the U.S. Army Dugway Proving Ground: John W. Barry

I. Introduction

The author received an invitation from the program chairman to discuss: (1) the aerial spray testing procedures, capabilities, and facilities at the U.S. Army's Dugway Proving Ground, Utah and (2) the Dugway Proving Ground/U.S. Forest Service Cooperative Program.

II. Dugway Proving Ground (DPG)

Dugway was activated as a site for testing chemical and flame munitions in March 1942. Following W.W. II it was inactive until the Korean conflict. It was reactivated in July 1950 and became a permanent installation in 1954.

Dugway comprises 1,300 square miles which makes it slightly larger than the state of Rhode Island. The maximum dimensions are 52 miles east to west and 30 miles north to south. It is the only Department of Defense proving ground in the continental United States where field testing (both ground and aerial releases) of chemical agents can be conducted.

Within its test and evaluation mission, DPG is charged with planning, conducting, and reporting on assigned development tests to assess the military value of chemical weapons and chemical/biological defense systems. This mission includes flame, incendiary and smoke munitions.

All test requirements are received by the Program Control Office at DPG where they are integrated into the installation program. Plans and Studies Directorate, working with the development laboratories or the customer, is responsible for definition of the details of the specific test plan and Test Operations Directorate is responsible for test execution. Management and administrative support is provided by the Program Control Office and the Comptroller Office.

The combination of geographic and meteorological conditions at DPG provides an ideal environment for testing a wide variety of weapons and defensive systems.

A requirement for the scheduling of field trials and for analysis of trial data is the acquisition of meteorological information prior to and during the conduct of a trial. A variety of sensors, data receiving and recording equipment are used to obtain this information and reduce it to useable form so that the test officer knows the current meteorological situation throughout the Proving Ground. He is then able to estimate both range safety and actual test conditions.

To increase testing safety further, DPG has installed a weather radar which has a range capability of 200 miles. The range is reduced by terrain masking to 120 miles. This, however, exceeds the safety requirements which dictate a tracking capability of at least 100 miles.

An Air Force operated weather station located at Dugway provides technical services in support of the test program and serves as an important element of weather coverage in the Western United States.

Aviation support from the 13,000 foot runway of Michael Army Airfield, located in Ditto Technical Center is available. This airfield can accommodate cargo aircraft as large as the C5A.

Located in Ditto Technical Center is a very specialized photographic laboratory that complements other data acquisition systems. This facility has high speed cameras which are capable of tracking artillery rounds, missiles and aircraft.

A life sciences laboratory was originally built to support tests of biological agents and munitions systems, but is now utilized in the field of biological defense. It is well instrumented to support large scale defensive tests involving simulants and fluorescent tracers as well as investigations in the areas of ecology and toxicology.

The total range system encompasses a complex of test grids each of which is designed to accommodate as wide a range of requirements as possible yet provide the desired degree of specificity.

One of the main grids used at Dugway is the Tower Grid. It is centered around a central munition impact point and is used for chemical field tests to determine munition efficiencies and chemical agent behavior from a point source release.

The West Vertical Grid is used for testing point source releases to provide data on efficiency, particulate dissemination, source strengths, downwind travel and agent decay. The grid is constructed with sampling stations located in a circular pattern at distances from 25 meters to 2,400 meters from grid center. After sampling equipment is in place this array can be rotated to any position on the arc to provide 360° wind direction capability.

A unique system located at DPG is the model 777 radar/photo instrumentation system. The system consists of an acquisition radar connected by microwave to a computer central which in turn is connected by microwave to mobile cinetheodolites providing a capability of determining and recording the point in space location of an aircraft or projectile during its trajectory and functioning sequence.

The Aerial Spray Grid is used to characterize aerial spray systems and for meteorological studies. This test array consists of 300' sampling and meteorological towers, 100' towers, and surveyed sampling positions downwind to 30 miles.

The Horizontal Grid consists of a half mile by a half mile square with sampling stations at 50' intervals. This grid is used to determine deposition patterns and swath widths. The U.S. Forest Service DC-3 spray system was tested on this grid in 1972.

Approximately 75% of the 1,300 square miles of the Proving Ground is available for field testing. One half of this area is intensively used. The remainder serves as a safety buffer.

The large geographic complex at Dugway can be instrumented for a wide variety of field and laboratory tests. Dugway has restricted air-space and offers a wide variety of climatic conditions and terrain features.

DPG has a meteorological capability that spans the spectrum from basic turbulence and diffusion research through practical applications.

III. DPG/USFS Cooperative Programs

A. Nezperce National Forest

The U.S. Department of Agriculture, Forest Service, and the U.S. Army Deseret Test Center (DTC) jointly conducted a test in the Nezperce National Forest, Idaho, during June 1971. The test site was in complex mountainous terrain covered by a mixed coniferous forest. Overall test control was the responsibility of the Forest Service, with DTC providing meteorological support, aerosol sampling equipment, and laboratory analysis of samples. This test, consisting of one trial, demonstrated the feasibility of controlling the spruce budworm by disseminating a dry-liquid insecticide (FS-15 Zectran + Micro Cel E) from a standard agriculture spreader carried by the Cessna Agwagon aircraft. The test also showed that diurnal drainage wind, during early morning hours, is an effective transporter of small aerosolized particulates when released below the inversion layer. The rotorod aerosol sampler was effective in collecting the dry-liquid particulate of Zectran and defining the area which the aerosol covered. The predicted

below-canopy dosage generally exceeded observed values, suggesting the need for additional information about the below-canopy environment, especially the complex effects of geographical features. No significant insect mortality was observed in this trial. It appears that under the conditions of this trial with the particulate size range of the aerosol, dosages in excess of 10^9 particle-seconds per cubic meter may be required to achieve significant budworm kill. It is hypothesized that the low budworm mortality resulted from a low impaction efficiency of the small particles and an insufficient amount of Zectran being released over the target. Impaction efficiency was estimated to be less than 1 percent. To achieve a 90-percent mortality rate, an estimated 10,700 to 34,700 particles in the 3.5-micron size range would be required, compared with only 3 to 10 particles in the 35-micron range. Additional tests are indicated to determine optimum particle size, initial source strength, and atmospheric conditions most conducive to particle impaction for maximum budworm kill. Recommendations are provided for improvement of aerial spray techniques for future applications of insecticides against the spruce budworm.

B. Dugway Proving Ground and Lolo National Forest

Deseret Test Center (DTC) and the U.S. Forest Service (USFS) conducted a cooperative test during April-June 1972 to obtain aerial spray data on the U.S. Air Force PWU-5/A Modular Internal Spray System (MISS). A standard USFS spray system was characterized to serve as a baseline, and to satisfy the licensing requirements for the insecticide Zectran which was used in the MISS. Both systems were installed in C-47 aircraft.

Six trials were conducted on the Horizontal Grid at Dugway Proving Ground, Utah, three with the USFS system and three with the MISS. An operational trial was conducted in the Lolo National Forest in Montana to demonstrate the effectiveness of the MISS and to obtain data on the filtration effects of coniferous trees on particulate sprays. A malfunction of the MISS pump main bearing necessitated termination of the spray operation before the entire 3,000 acre target area had been sprayed. Printflex card samplers were used to determine spray parameters. Spruce budworm larvae were employed to demonstrate the system effectiveness and to study correlations between percent mortality of larvae and contamination densities.

Both systems were characterized according to droplet size spectrum, effective swath width, and deposition density over open, flat terrain. The mass median diameter of the Zectran FS-15 mixture was determined to be 120 microns, plus or minus 10, when disseminated from either spray system.

Data from the Montana trial indicated that fewer of the larger droplets (greater than 109 microns) reached the ground samplers than the smaller droplets (65 to 109 microns), resulting in a significant reduction in the total mass deposited on the forest floor. An excellent correlation was obtained between the values predicted by the DTC modified mathematical model for spray operations on open terrain.

Additional testing is recommended to improve operational procedures and to define problems associated with meteorological and particulate cloud behavior in complex mountainous terrain.

C. Lolo National Forest

The U.S. Forest Service, supported by Deseret Test Center, conducted a field test during June 1972 in the Lolo National Forest, Montana. The objective was to investigate the impaction of dry-liquid Zectran particles on the western spruce budworm larvae as a function of particle size. A helicopter was used as the dissemination vehicle because of the downwash effect which assists aerosol penetration of the forest canopy and enhances particle impaction. Rotorod samplers and glass impaction slides were used to obtain aerosol and particle size data. Budworms and fir needles were examined, and impacting particles were counted and measured. Eighty-seven percent of the particles observed on the fir needles were equal to or less than 10 microns in diameter, and 87 percent of the particles observed on the budworms were equal to or less than 15 microns in diameter. The results and conclusions, although based upon relatively limited data, provide baselines for planning future experiments.

IV. The Integrated Test Team

A test team whether established to conduct a field experiment, pilot test, or control project for forest insect control by aerial methods should consist of various engineering and scientific disciplines. The complexity of the problem in obtaining successful field data no longer can be realized singly by entomologist, or foresters or biologists without the coordinated efforts of the following disciplines:

Entomologists
Engineers
Meteorologists
Foresters
Chemists
Pilots
Statisticians
Biologists

The role of these professionals as a member of an integrated test team is as follows:

Entomologists - Project leader, laboratory, surveys, environmental studies, field crew, and supervision of sampling teams

Engineers - Spray systems, spray sampling, spray plot measurements and making aerial surveys

Meteorologists - Spray forecasting, meteorological measurements, terrain analysis, flight weather forecasting, micrometeorological studies, data analysis, drift prediction and evaluation, spray modeling, and application strategy

Foresters - Land management, land use, goals, criteria for spraying, objectives, project coordination

Chemists - Spray formulation and concentrations, measurements, assessment of samplers, dose/insect studies

Pilots - Proper application as per project officers plan, coordination with Engineers and Entomologists

Statisticians - Sampling plan, data evaluation

Biologists - Field sampling, environmental impact studies, coordination with specialists, biological spray formulations.

Of these various disciplines the least heard of and often the most essential to a successful spray operation is the meteorologist. We often blame poor results on the wind, on the stability conditions, temperature, solar radiation, etc., but how many times do we make these measurements? When we do, who evaluates the data and applies the lessons learned to our next spray operation?

The basic weather elements which should be measured on spray plots are:

- Wind speed and direction above and below the canopy
- Relative humidity (2 meter)
- Temperature profile (surface to the canopy and canopy to the release height)
- Cloud cover percent
- Barometric pressure
- Sunrise time (when sun hits the spray block)

V. Spray Behavior Research

Dr. P. H. Southwell published a paper in the Transactions of the ASAE dated 1973 entitled "Progress in the Technology of Chemical

Applications by Aircraft." This paper is an excellent summary of the state of the art and a definition of problems related to aerial spray. Everyone who is involved in the conduct of aerial spray projects whether they are researchers or insect control oriented would gain considerable insight into the aerial spray problem by reviewing this paper. If the problems of today and those of the future are to be solved, a coordinated effort by industry, government, and the educational institutions will be required.

WORKSHOP: COST-BENEFIT EVALUATIONS

Moderator: Alfred M. Rivas

Economic Considerations in Benefit-Cost Analysis: Robert G. Williams

I appreciate the opportunity to participate in this work conference. As an economist, it is gratifying to me that you have allotted a part of your time to a discussion of benefit-cost evaluations of insect programs. At a time when we are operating under the constraint of a limited budget, we obviously cannot initiate all programs we would like or perhaps even those we feel are necessary. Therefore, it is important that we invest our dollars in those programs which will provide the greatest return. By subjecting programs and proposals to an economic analysis, we can help insure we do, in fact, receive maximum benefits for each dollar spent. With this in mind, I would like to present what I believe are some important factors which should be considered in applying a benefit-cost analysis to insect programs.

Consideration of Alternatives

Unfortunately, benefit-cost analysis is often used incorrectly. It is a mistake to use this type of analysis to attempt to justify a proposal. Rather, benefit-cost analysis is most effective when it is used to determine which alternative is best--after it has been previously decided that all alternatives are viable and only the problem of selection remains.[1]

The first step then in a good economic analysis, or for that matter any analysis, is the selection of alternatives. Selecting alternatives should not be done merely for the sake of considering alternatives, but rather with the idea of determining objectively, from reasonable alternatives, the best possible course of action. All

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[1] Frederic O. Sargent, A Resource Economist Views a Natural Area (Journal of Soil and Water Conservation, January-February 1969.

alternatives selected for consideration should be viable from physical, economic, social, and environmental standpoints.[2/]

Being unfamiliar with the science of entomology and its application to National Forests, I will not attempt to offer advice as to which alternatives you should consider in insect control programs. I am sure you will agree, however, for most such projects there are different methods of getting the job done. Two alternatives which appear obvious are maximum control and to do nothing. Within this wide spectrum other courses of action can be identified. After several alternatives have been selected, benefits and costs for each can be estimated and compared.

Benefits and Costs

If a program of insect control is proposed, I assume, in most cases, benefits would be identified as increased merchantable timber. And, for each alternative, a different level of timber harvest would be possible.

On the other side of the ledger, different items of cost can be identified for each alternative. If different types of treatment are involved, costs will vary. Also, intensity and duration of treatment will affect costs.

An example of an economic analysis may help to illustrate. Assume an area has been identified for possible treatment to suppress an insect problem. It is estimated that if no action is taken, annual timber harvest from the area will decline from an average annual cut of 1,000,000 board feet - assuming a 20-year program of full control (alternative A)-to 250,000 board feet (alternative B). Another level of control would allow a harvest of 10,000,000 board feet annually during the first two years and none thereafter (alternative C). Further, assume that timber has a value of $130 per thousand board feet.[3/]

[2/] U.S. Forest Service, Intermountain Region, Guide for Land Use Planning Multiple Use Management, Ogden, Utah 1973.

[3/] Considerable time could be spent in debating the correct value to use for timber, i.e., stumpage, value of logs at the mill, as lumber, or as a finished wood product. Without discussing pros and cons of which value to use, suffice to say the value used in this example and the value I believe best identifies timber benefits is the price paid for logs delivered to the mill. Additional benefits which should be identified and evaluated will be discussed in a later section.

benefits and costs which occur over a period of years, it is necessary to bring them to a common point in time. This can best be accomplished by discounting. Discounting is simply a procedure of using interest rates to convert values which occur over time to a present value.[4/]

Table 2 is a summary of benefits and costs discounted to the present using a 6-7/8 percent interest rate.[5/]

In examining table 2 the effects of discounting are apparent. For example, in both alternative A and C total timber harvested will be 20 million board feet. However, benefits for timber harvest in alternative C are nearly one million dollars greater than alternative A. The difference being benefits from timber in alternative C are realized during the first two years of the analysis and thus are not discounted to the same extent as in alternative A. The implications are obvious - to maximize benefits, projects should be structured to yield benefits as soon as possible while deferring costs for as long as possible.

A comparison of benefit-cost ratios indicate alternative B should be selected. However, using a benefit/cost ratio as the only criterion for selecting an alternative may not always lead to the best selection. I believe Dr. Michalson plans to discuss some of the shortcomings of benefit/cost analysis, so I will not elaborate further, except to point out that in table 2 the alternative with the highest benefit/cost ratio (alternative B) is not the alternative with the greatest net benefits (alternative C).

[4/] For a discussion of the appropriate rate to use in benefit/cost analysis of government programs see: Water Resources Council, Water and Related Land Resources, Establishment of Principles and Standards for Planning, Federal Register, Volume 38, Number 174, September 10, 1973.

[5/] Interest tables are available in USDA Forest Service Research Paper NC-51, Tables of Compound - Discount Interest Rate Multipliers for Evaluating Forestry Investments, by Allen F. Lundgren.

Alternative A is estimated to incur annual treatment costs of $100,000 per year for the first 15 years, monitoring costs of $10,000 per year, years 15 through 20, and annual timber sale administration costs of $3,000. Alternative B has no treatment cost, annual timber sale administration costs of $750, and monitoring costs of $10,000 per year. Alternative C has treatment costs of $250,000 during the first two years, monitoring costs of $3,000 years 3 through 20, timber sale administration costs of $30,000 in years 1 and 2, and planting costs of $100,000 in year 3. Benefits and costs and time of occurrence are summarized in table 1.

TABLE 1

SUMMARY OF BENEFITS AND COSTS

	Alternative A	Alternative B	Alternative C
Benefits			
Timber Harvest (M board feet)	1000 @ $130 ann. - 20 yrs.	250 @ $130 ann. - 20 yrs.	10,000 @ $130 years 1 and 2
Costs			
Treatment	$100,000 yrs 1-15	0	$250,000 yrs. 1 and 2
Monitoring	$10,000 yrs. 15-20	$10,000 annually	$3,000 yrs. 3-20
Timber Sale Administration	$3,000 annually	$750 annually	$30,000 yrs. 1 and 2
Planting	0	0	$100,000 year 3

Discounting

It is important not only to accurately estimate the level of benefits and costs but also to identify when benefits and costs will occur. This is necessary because the value of money varies with time. A dollar received today is worth more than a dollar which will be received at some future date. Likewise, a cost which must be paid today has a higher value than the same amount payable at a future date. Therefore, to effectively compare

TABLE 2

PRESENT VALUE OF BENEFITS AND COSTS -

DISCOUNTED AT 6-7/8 PERCENT INTEREST

	Alternative A	Alternative B	Alternative C
Benefits			
Timber Harvest	$1,390,800	$347,700	$2,354,300
Costs			
Treatment	982,800	0	452,800
Monitoring	18,900	107,000	27,400
Timber Sale Adm.	32,100	18,000	54,300
Planting	0	0	822,000
TOTAL	$1,033,800	$115,000	$1,356,500
Net Present Worth	$ 357,000	$232,700	$ 997,800
B:C Ratio	1.3:1.0	3.0:1.0	1.7:1.0

INVEST III Computer Program

The preceding example was purposely simplified and was designed to illustrate concepts rather than attempt to identify all benefits and costs which could possibly occur. In most cases, problems you will actually be concerned with will be considerably more complex and have more benefits and costs to consider. If this is the case, or if several alternatives are involved, it may be advantageous to utilize computer facilities for evaluation. The INVEST III computer program appears to be ideally suited to the type of analysis required for many of your projects.

The INVEST III program was developed by Dr. Otis Hall at Purdue University. It was later revised for natural resource management by Forest Service personnel in Region 5. The program computes a net present worth, benefit/cost ratio, and internal rate-of-return for a proposal and for any number of alternatives. The user need

only specify costs and benefit values and the time schedule for each. The program discounts all costs and benefits at a single interest rate specified by the user and provides a display of individual benefit and cost items. In addition, benefit/cost ratios and net present worths are calculated at four different interest rates which may be specified by the user.[6]

Consideration of Nonpriced Resources

An economic evaluation is a useful tool in selecting the best alternative to undertake. However, it is only one tool and, to be effective, it must be used in conjunction with other considerations which cannot always be quantified and expressed in terms of dollars or benefit/cost ratios. For example, does a proposed insect program have a positive effect on wildlife habitat? If so, this is a consideration which should be recognized and evaluated. What is the value of a healthy green forested appearance of a landscape as opposed to one which has been decimated by insects? Looking at the cost side for a moment - what are the costs of possible water quality degradation or increased sediment in a stream?

In addition to the so-called "direct benefits," consideration should also be given to "secondary benefits." By these I mean increased jobs, wages, and income which could be generated by, say, an increased level of timber harvest. In many instances, these factors are very important and, if they appear to be substantially affected, the effects should be considered in the selection of an alternative.

In recent years economists have made considerable progress in developing methods for establishing a dollar value of resources which are not bought or sold on the market. However, methods have not yet been developed which will allow us to establish, with an acceptable degree of accuracy, values for all items which must be considered in a complete analysis of proposals which deal with natural resources. Nevertheless, in many cases, these factors will be important, if not overriding. It is necessary, therefore, to recognize and consider these values in conjunction with a benefit/cost analysis.

Summary

To summarize, let me reiterate what I consider to be important in an economic analysis:

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[6] A copy of the INVEST III users guide is included in Section 425, Intermountain Region, Guide for Land Use Planning, Multiple Use Management.

1. The analysis should evaluate several alternatives and not be used merely to justify a proposal.

2. To the extent possible, all benefits and costs should be quantified and expressed in dollars.

3. Dollar costs and benefits should be discounted at an appropriate rate of interest and compared at a common point in time.

4. Values which cannot be quantified or expressed in dollars must be identified and considered.

Benefit-Cost Analysis Applied to Pest Management Strategies*: E. L. Michalson

Introduction

A basic problem facing resource managers involved in pest control is that of measuring the effectiveness of alternative control strategies. Several approaches may be used to do these evaluations such as budgeting costs and returns, developing systems analysis approaches such as linear programming or dynamic programming systems, and Benefit-Cost Analysis. In the case of budgeting costs and returns the analysis is only a partial approach in that relative comparison of costs to income is made. The use of a systems analysis involves the determination optimum control strategies considering all possible combinations of alternatives. The method would require complete specification of alternatives, large quantities of data, and is expensive both in time and money. Benefit-Cost Analysis requires more information than is required for budgeting costs and returns, and less than what is required for the systems analysis methods.

Benefit-Cost Analysis is looked at with favor by many resource planners as a means of both evaluating and justifying various kinds of resource investments because it requires less data and analysis than systems methods and is a more powerful analytical tool than is simple budgeting. It provides a means of looking at a range of alternative strategies, determining their best size, and allows the planner to choose one which will reasonably meet specified goals.

*The work reported herein was funded by an IBP sponsored project entitled, "The Principles, Strategies, and Tactics of Pest Population Regulation and Control in Major Crop Eco-Systems," (NSF-GB34718).

In evaluating pest control strategies, the objective would be to select those which have the greatest promise of success. To do this it is necessary to have data available on types of control, their effectiveness, costs, and estimates of the benefits to be received. These data are then evaluated using benefit costs analysis to determine their effectiveness.

Benefit-Cost Analysis Methodology

Benefit-Cost Analysis is utilized to guide the use of economic resources in ways that will increase the effectiveness with which they are used. As a methodological technique it emphasizes economic efficiency in resource use; and although it does not optimize resource use, it points toward the direction of optimum resource use. The assumptions on which it operates are: (1) that the strategies being evaluated have economic value because a need or desire exists for them; (2) that each strategy should be developed to the scale which provides the maximum benefits above costs; (3) that separable segments of control strategies should be developed at minimum cost; and (4) that the priorities assigned to the pest control strategies should follow the order of their economic desirability.[1/]

In Benefit-Cost Analysis it is necessary to define what is meant by benefits and what is meant by costs. Basically, there are two types of benefits and three types of costs. The two benefits are primary benefits which flow directly from the strategy and secondary benefits which occur as additional values stemming from or induced by the strategy. Secondary benefits are not claimed unless it can clearly be shown that an increase in net incomes results compared to what would result without the strategy.

In the case of defining costs, there are "strategy costs" which include the value of all the goods and services which go into applying the strategy. These would include the costs of materials, labor for application, and equipment costs. The second costs are the "associate costs" of any goods or services which would make the end product available for sale.[2/] In the case of a mountain pine beetle control strategy, an associated cost might be planning of timber sales. Finally, there are the secondary costs which are the values of the goods and services required in addition to the strategy and associated costs. In our strategy example these would be lumber milling costs which make the timber merchantable.

The procedure followed is to identify and measure benefits and

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1/ Barlow, R., "Land Resource Economics," Prentice Hall, Inc., Second Edition, 1972.

2/ Ibid.

costs. Once these have been estimated, any surplus of primary benefits above strategy and associated costs can be called a primary net benefit, and any surplus secondary benefits above secondary costs can be called a secondary net benefit of the strategy involved. In most cases we are interested in the primary net benefits.

In the process of measuring benefits and costs, consistent standards should be used in the selection of prices, interest and discount rates, allowances for risk and uncertainty, and other facts of economic life. It is usually recommended that calculations of benefits and costs be done in terms of the price levels expected at the times when the benefits and costs will occur. In the case of a pesticide control strategy, the costs would be estimated at the time the strategy would be applied. The benefits would be estimated in terms of when they were expected to accrue. This implies that future benefits and costs should be evaluated in terms of their present values. This means that a time horizon needs to be defined, and a proper discount rate needs to be selected to properly reflect the risk and uncertainties involved in applying pest control strategy in question.

The appropriate way to discount benefits and costs in a benefit-cost analysis has been formulated by O. Ekstein.[3] It is derived as follows:

(1) Present value of total costs:

$$\sum_{t=1}^{T} \frac{0}{(1+i)\ t} + K;$$

(2) Present value of total benefits:

$$\sum_{t=1}^{T} \frac{B}{(1+i)\ t} \text{; and}$$

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[3] Eckstein, O., "Water Resources Development," Harvard University Press, Fourth Printing, 1969.

(3) The benefit-cost ratio is:

$$\sum_{t=1}^{T} \frac{B}{(1+i)^{t}} \left[\sum_{t=1}^{T} \frac{O}{(1+i)^{t}} + K \right]^{-1}$$

Next, the ratio is placed on an annual basis by dividing the numerator and denominator by:

(4) $$\sum_{t=1}^{T} \frac{1}{(1+i)^{t}}$$

we get,

(5) $$\frac{B}{C} = \frac{B}{O+K\left[\sum_{t=1}^{T} \frac{1}{(1+i)^{t}} \right]^{-1}};$$

and letting,

(6) $$\left[\sum_{t=1}^{T} \frac{1}{(1+i)^{t}} \right]^{-1} = A_{i}T;$$

we can write,

(7) $$\frac{B}{C} = \frac{B}{O+a_{it}K};$$

where: B = benefits received annually,

C = cost per year indluding the charges for capital

K = fixed investment,

O = operating, maintenance, and routine replacement costs incurred annually,

i = interest rate, and

T = amortization period

Developing a Benefit-Cost Model

Development of a pest control strategy requires that: (1) a need be established for the strategy; (2) that the best size of treatment be determined; and (3) that the least-cost method of implementing the strategy be determined. The first step is determining that there is a demand or desire for the control. This may seem

obvious, but it is necessary because we want to be able to justify the expenditure of funds.

The second step is that of determining the optimum size or application of the control or treatment. The size of treatment will be optimal when more net benefits are produced by a specific size of treatment than by any larger or smaller scale treatment. This is illustrated in the generalized graph shown in Figure 1. The upper portion of the graph is a typical benefit-cost diagram in which the relationship of total benefits and costs is shown. The lower portion shows the ratios of marginal benefits and costs, and the ratio of total benefits and costs. The ordinate on the upper graph is labelled total benefits and costs in dollars, and on the lower graph it is labelled ratio of benefits to costs. The abscissa on both graphs is labelled size of treatment.

The total costs are linearly increasing and are shown as a 45° curve AD beginning at the origin and extending over all possible sizes of development. The total benefit curve defined by ABCD indicates that over some portion of the curve, benefits exceed costs. The question is: Where are net benefits maximized? In order to determine this relationship the lower part of the graph is used, and the marginal increments of benefits and costs are evaluated in light of the ratio of benefits to costs. This is the essence of the benefit-cost analysis.

In determining the scale of treatment we need to decide what level will bring us the optimum size. What we want to determine is that size of treatment which will provide us with the maximum net benefits. Looking at the lower part of Figure 1 we observe that ratios of total benefits and costs range from less than 1.0 to 1.5 and decline to 1.0 again as size increases. This curve specifies the range in treatment size which should be considered. If one chooses to size treatments based on the maximum benefit-cost ratio using this curve, the treatment size is defined by point B. Unfortunately, this is not the optimal size treatment.

To determine optimal treatment size it is necessary to examine the curve of ratios of marginal increments of benefit to marginal increments of costs determined when this curve intersects the benefit-cost ratio equal to 1.0. This occurs at point C, and defines the optimal size of treatment. The optimum size of treatment will typically occur at a benefit-cost ratio less than the maximum which occurred at point B.

Economic Feasibility

The last step in the Benefit-Cost Analysis is the determination of economic feasibility. This procedure involves discounting the estimated benefits and costs to obtain their present values. Then

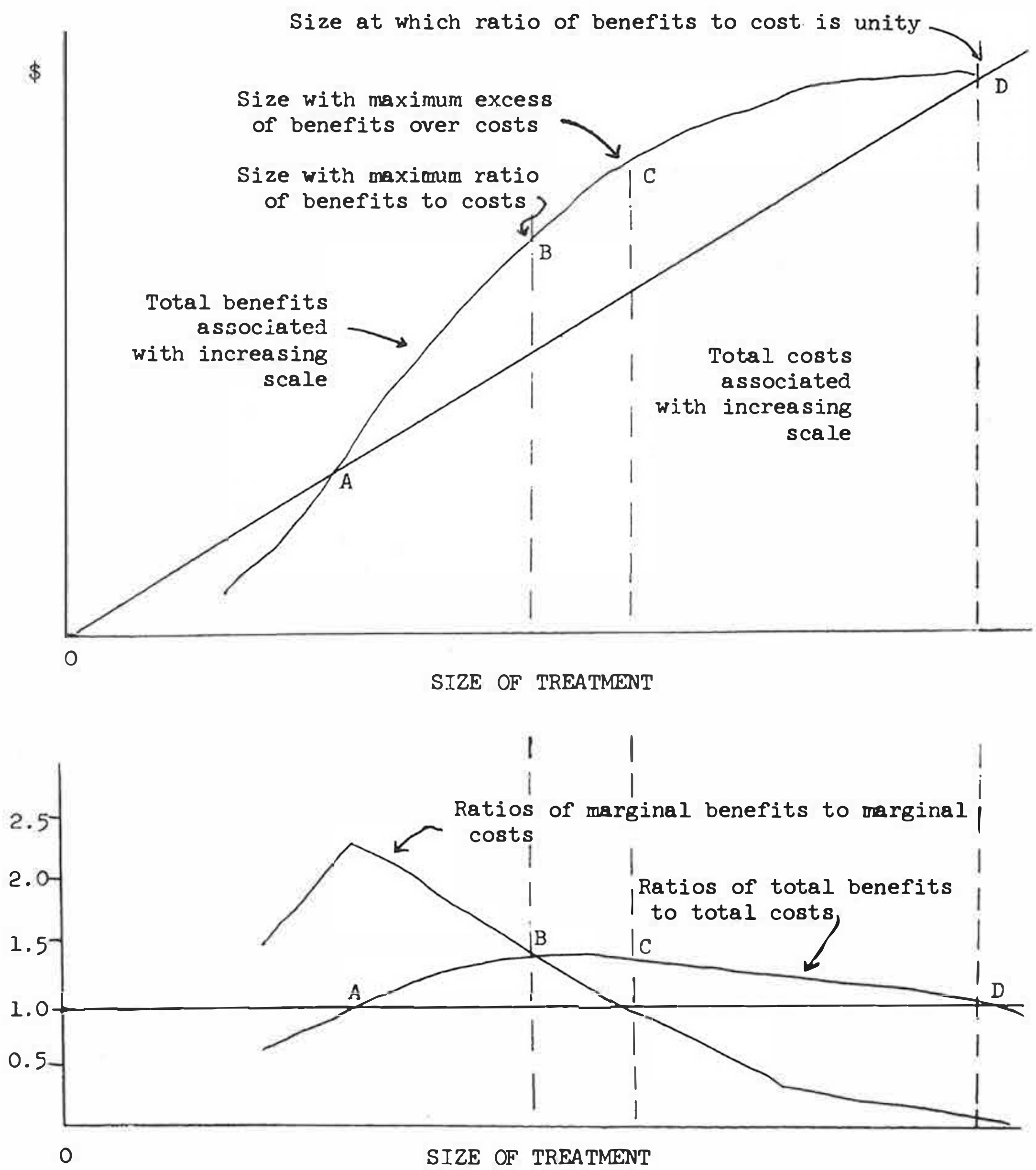

Figure 1: Relationship of Benefits and Costs for Pest Management Strategies Involving Different Sizes of Treatment

a determination of each strategy can be made. Four methods of determining economic feasibility are used. These methods are shown below:

1. B-C (Measures net benefits)
2. B-C/C (Rate of return)
3. B/C (Benefit-Cost ratio) and,
4. B-OC/IC (Rate of return on investment)

where:

B = economic benefits
C = economic costs
OC = operating costs
IC = investment costs

An example of the use of these ratios is provided in Table 1. The benefits and costs are listed in the upper portion of the Table and the measures of net benefits in the lower portion. Examining the Table: (1) the annual net benefits range in value from \$22,500 to \$45,000; (2) the simple rate of return from 30 to 60 percent in the opposite direction; (3) the benefit-cost ratio declines from 1.6 to 1.3 as the size of treatment increases; and (4) the internal rate of return varies from 175 to 225 percent.

All of these ratios indicate something about each pest control strategy considered. The ratio used to measure the effectiveness of the project depends upon the goals of the overall pest control program. If money is not a limiting factor, then the B-C or B-OC/IC ratios could be used.

The B-C ratio permits the maximization of net benefits regardless of costs. The B-OC/IC ratio emphasizes the rate of return on investment and allows one to choose the maximum rate of return which corresponds to the maximum net benefits in most cases. If money is a limiting factor, then the criteria for choice would be the B/C and the B-C/C ratios. The B/C ratio tends to select on the basis of economic efficiency instead of maximum net return, as does the B-C/C ratio.

These two sets of ratios provide conflicting guidelines concerning the comparative priorities which might be assigned to the alternative strategies. Alternative A has the highest benefit-cost and B-C/C ratios, and Alternative D has the highest B-C and B-OC/IC ratio. These results emphasize the importance of the goals in determining the criteria to be used in selecting the alternative to be used.

Table 1. A Hypothetical Comparison of Rates of Return and Benefit Cost Ratios for Three Alternative Pest Control Strategies.

	Alternative Pest Control Strategies			
	A	B	C	D
	(value in $000's)			
Annual value of benefits	$ 60	$ 72	$126	$195
Annual operating costs	7.5	18	54	114
Annual share of investment costs	30	30	36	36
Measures of net benefits				
1. B-C (net benefits)	$ 22.5	$ 24	$ 36	$ 45
2. B-C/C (rate of return)	60%	50%	40%	30%
3. B/C (benefit cost ratio)	1.6	1.5	1.4	1.3
4. B-OC/IC (rate of return on investment)	175%	180%	200%	225%

Critique of B/C Analysis

From the positive point of view the argument is that some method of evaluation is desirable in guiding public investments. B/C analysis provides a logical, easily understood way of evaluating proposed federal or state investments in pest control programs. It has been a standard procedure used for many types of federal infestments over the last 50 years.

On the negative side B/C analysis is a partial analysis because the actual decision-making process is not economic but social or political in nature. It may suffer from inadequate specification and/or data. This implies that the benefits and costs are often inadequately specified with the result that benefits (or costs) may be overestimated and costs (or benefits) underestimated. Often there is disassociation of benefits and costs. In other words, the group which pays the costs may not receive the benefits. Finally, one of the more important issues in B/C analysis is that of the discount rate or rates used to estimate the present values of future benefits and costs. Higher present values are obtained

using lower discount rates, while lower present values result from the use of higher discount rates. Federal agencies use discount rates varying from 3 to 12 percent usually. In some cases they have not used the discount procedure in the project evaluation process.

B/C analysis can be used effectively as a general guide for evaluating the relative economic efficiency and feasibility of various pest control strategies or programs. It is best used in this fashion when the goals of the program are clearly stated and understood. It can also be used as criteria to compare and select alternative pest control strategies. Its advantages are that it is a relatively effective method of evaluating these kinds of investments and providing guidelines for public investments.

Economic Evaluation of Mountain Pine Beetle Control in the Targhee National Forest: Alfred M. Rivas

The Targhee National Forest is situated in eastern Idaho and western Wyoming adjacent to Yellowstone National Park. It has extensive stands of lodgepole pine which have been periodically infested by large outbreaks of mountain pine beetle.

The present infestation began in 1960 and large scale control efforts started in 1962. Control efforts were undertaken to protect multiple use values which were never quantified. Control costs through 1970 were 10.3 million dollars.

In 1967 it became apparent that our control activities were only an expensive delaying action. Further control could not be justified unless the control investment could be capitalized as a result of the time "bought." The position statement issued by the Forest Service in 1968 on this infestation recognized the treating program as a delaying action, and was concerned with accelerating harvest to utilize the threatened material within the time bought by treating. The bark beetle suppression project conducted from 1968 through 1970 was undertaken to slow the rate of attack until accelerated timber harvesting could remove the maximum threatened volumes. The existing timber industry was operating at maximum capacity during the late 1960's. Over 400 million board feet, most of it lodgepole pine, was already under contract.

An accelerated sale attempt, to attract new milling capacity, failed in the spring of 1969 due to erratic market conditions. The Warm River Timber Sale of 150 million board feet was sold in

December of 1969 to accelerate the removal of threatened timber.

Concern developed in 1970 over the slow rate of harvest on the Warm River Sale. As a result of that concern, a benefit cost analysis was prepared to better determine the levels of present and proposed expenditures necessary to protect the expected harvest volume. The analysis involved inputs from and meetings between economists, entomologists, and foresters. Within the framework of our considerations, including the cutting schedule, we could only conclude that the costs of insect control would outweigh the monetary benefits from the timber made available on the Warm River Sale.

Our analysis considered objectives of the control project, the Warm River Sale, and the analysis itself. The objective of the control project was to delay the rate of tree mortality on the Warm River Sale long enough for the purchaser to cut and remove 135 million board feet by March 31, 1976.

Our Warm River Sale objectives were:

1. The salvage of stumpage volume and value that would otherwise be lost.

2. Development of the transportation system.

3. Creation of fuel breaks and conversion of decadent stands to thrifty seedling and sapling stands.

The objectives of the analysis were to:

1. Estimate whether or not continued control efforts were needed to permit completion of the Warm River Sale.

2. Determine what benefits will be gained from completion of the sale.

3. Project control costs for the life of the sale.

4. Estimate whether projected benefits exceeded the costs.

5. Consider alternative means of meeting management objectives for the control project and the Warm River Sale.

Four different treatment levels were considered. They were:

1. Treatment each year 1971-74.

2. Treatment in 1971 only.

3. No further treatment.

4. Treatment in 1971-72.

Assumptions basic to the analysis included estimated annual tree mortality losses, control costs and residual green and dead merchantable timber. Figures for all estimates were based on considerable data from the area. Other information used in the analysis included volumes cut, decked, hauled, and estimated to be hauled; estimated miles of road constructed, surfaced, or incomplete; stumpage, slash and timber stand improvement values; recreational considerations, and effects on the local economy.

Three main conclusions were reached. First was that the removal of the advertised sale volume could only be achieved by treating through 1973. That treatment alternative would have cost some $47.23 per thousand board feet for the 62 million board feet made available for harvest. Secondly, there would have been a benefit-cost deficit of $15.81 per thousand board feet for the 31 million board feet made available for harvest if treating were conducted only in the currently infested trees. Third, of the four alternatives, only two, control in 1971 only or no further control, seemed viable alternatives.

The decision was made to conduct no further control.

Douglas-Fir Tussock Moth Benefit/Cost Analysis: Donald J. Curtis

The benefit/cost analysis includes a consideration of the losses to timber and recreation, the additional cost of fire suppression, and the probable gain in grazing values that will result if the present outbreaks continue in 1974.

The calculations include only those values which can reasonably be expected to change if virus or other factors do not significantly reduce the tussock moth populations early in the 1974 growing season and if no direct control action is taken.

The projected losses for timber include mortality and growth loss for both mature and immature stands and reforestation expenses. For the purposes of this analysis mature timber is considered to be merchantable timber larger than 10 inches d.b.h.

The volumes per acre, growth rates per acre, stumpage values for both dead and green timber, reforestation costs, the percentage of mature timber in the infested areas, and the percentage of mortality that can be salvaged are best estimates provided by the various land managers.

The volumes of mortality are based on best estimates of the percentage of dead trees within the various damage categories mapped during the 1973 fall helicopter surveys. These include the following:

Damage Class	Mortality
Dead	Areas on which most of the host type is dead as a result of prior years' defoliation.
I	Areas on which 75 percent of the mature and 90 percent of the immature trees have been completely defoliated.
II	Areas on which 10 percent of the mature and 20 percent of the immature trees have been completely defoliated.

The class III acres of defoliation contained so few dead trees that no attempt was made to account for the scattered mortality.

The projected acres of damage were calculated by using conversion factors based on observed changes in defoliation intensity in the Blue Mountains.

The class-shift factors used were obtained by comparing the mapped results of the 1972 and 1973 fall helicopter surveys.

The maps were aligned and taped to a light table and examined on a point-by-point basis using a plastic overlay with 16 dots per square inch. The point under each dot was tallied according to the damage class in 1972 and the class that occurred in 1973. A total of 3,629 points were examined. The tally for each category was converted to a percentage of the total points falling in the 1972 class.

It was assumed that the proportional shift from a given level of damage in one year to other damage classes the following year would remain constant as long as the tussock moth populations remained at defoliating levels. It is anticipated that the C-S factors will change slightly in future years as more data becomes available.

The method of calculating the projected 1974 losses involved separating the damage actually attributable to the continued outbreak from the damage that had already been incurred. This was done in the following manner:

1. Calculating the cumulative loss using the projected 1974 damage class acres.

2. Calculating the overlap loss using the 1973 observed damage class acres that fell within the 1974 outbreak area.

3. Subtracting the overlap loss from the projected cumulative loss to yield the 1974 loss. The 1974 loss thus computed is the benefit that can be claimed if the 1974 outbreak is controlled.

The mortality loss of the immature stands was treated as a growth loss that would be recognized by the extra time required to bring the affected stands to a harvestable age.

The present net worth of the loss resulting from the mortality in immature stands was assumed to be well represented by subtracting the PNW of a stand at rotation age from the PNW of the same stand at rotation age less 30 years. It was assumed that the average age of the immature stands were 30 years. Standard discounting procedures were used to obtain the necessary factors. A discount rate of 10 percent as outlined in OMB circular No. A-94, dated March 27, 1972, was used in this evaluation.

The growth loss estimates are based on research by Wickman in white fir stands in California which indicates a reduction in annual growth on surviving trees by a factor of .74 in class I areas, .67 in class II areas, and .31 in class III areas. According to Wickman the surviving trees require 3 to 5 years to return to the preinfestation annual growth rates. For the purposes of this calculation, it has been assumed that growth loss during the infestation plus the recovery time would be well represented by considering the growth reduction factor to be operable for three years. Although this work was done in California, it is the best information currently available for calculating growth loss due to tussock moth outbreaks.

The value of the growth loss on mature timber will not be realized until the affected stands are harvested. Therefore, it is assumed that an equal amount of the affected stands will be harvested each year and that the value loss experienced each year will be the same. The yearly value loss is the total value loss divided by the regulation period. To find the present net worth of this loss, a discounted annual payment multiplier was computed using the estimated regulation period provided by the various land managers and the 10 percent rate of interest suggested in the OMB circular.

The value of the growth loss in immature stands will be realized at the time of harvest. Therefore, the PNW of the growth loss is the value of the loss discounted to the present from the rotation age less 30 years. For each ownership a multiplier was calculated

for the rotation age less 30 years. This multiplier was used to obtain the PNW of the growth loss.

For the overlap loss calculations, the growth reduction factor is assumed to be operable for only two years because one year of the three years of reduced growth has already elapsed. Even if the outbreak completely collapsed, the overlap acres would still experience a growth loss for two years. The intent of the calculations is to remove from the cumulative loss any loss that would occur even if the outbreak collapsed.

The reforestation expenses are based on an estimate of acres needing reforestation and the historical cost per acre to reforest in the various areas. The percent of the killed area to be reforested was estimated by each land managing agency.

As with other categories of impact, the overlap loss was subtracted from the cumulative loss to determine the loss attributable to a continuation of this outbreak in 1974. It is anticipated that the reforestation expenses will be incurred in the near-term and thus have not been discounted.

The additional cost of fire suppression, based on the 1974 defoliation projections, is a "best estimate" provided by the various land managers and include estimates of additional dollars needed for protection, fuel treatment, and suppression.

No dollar values were assigned to either the beneficial or adverse effects on wildlife if control is carried out. No significant loss is expected if control is carried out as planned.

The effect of the tussock moth defoliation on recreation in the Blue Mountain area is primarily on aesthetics, hunting and fishing. There are several high use, highly developed state parks in the infestation area, as well as two forest waysides which were purchased for the purpose of preserving timber stands on hillsides adjacent to and visible from Interstate Highway 80N. These parks and waysides have high recreational value which is threatened by the tussock moth outbreak.

There are eight USDA-Forest Service developed campgrounds and innumerable undeveloped or "hunter" camps through the area. The entire Blue Mountain area is prime elk and deer hunting area and thousands of hunters are in this area every fall. There are six major fishing streams in the area which attract fishermen all summer.

Dollar values applying to recreation uses were first implemented by the President's Water Resources Council, Senate Document No. 97, supplement No. 1 "Evaluation Standards for Primary Outdoor

Recreation Benefits," June 4, 1964. They were brought up-to-date in the "Guidelines for Supplementing Principles and Standards for Multi-objective Planning of Water Resources, Review Draft," December 1972. As designated in the above publication, general recreation activities were assigned values of \$.75 to \$2.25 per visitor day, and specialized recreation activities were assigned values of \$3.00 to \$9.00 per visitor day. The dollar value to be used within these ranges is dependent on the number of available alternative activities, the degree to which opportunities to engage in a number of activities are provided, the expected degree of hunting and fishing success as dependent on the character of fish and wildlife habitat and the general attractiveness of the area and uniqueness of the experience. Based on these categories, it was decided to average out the range of general recreation activities to \$2.00 per visitor-use day and the specialized activities to \$7.00 per visitor-use day.

Visitor-use day figures are available for the F.Y. 1973 season for National Forest, Washington State Parks, and the Oregon State Parks. No figures are available for private land, since no record on this type of information is kept by private landowners. Recreation use on private lands in this area is relatively minor, except for hunting and fishing.

It should be kept in mind that these dollar values do not include all of the economic benefits to the local area, state, or nation of these recreation uses, but only a portion of them. These figures give a very conservative recreation resources value that might be lost within the infestation area. The final cost/benefit figure should be analyzed with this in mind.

No dollar values were assigned to either the beneficial or adverse effects on watersheds due to defoliation of trees if no control is carried out.

It is estimated that there will be an increase in forage and browse of 8,700 animal unit months (AUM) for domestic animals due to the defoliation of trees by the tussock moth. This is a result of opening the canopy thereby reducing competition on grasses and forbs by tree cover. A market value for the increased forage production in the Blue Mountain area can be calculated as follows:

8,700 AUM X \$3.94 = \$34,278

If the tussock moth infestation remains unchecked, this increase may go as high as 25,700 AUM by 1974. Assuming the market value does not change, this could mean an annual increase in value as follows:

25,700 AUM X \$3.94 = \$101,258

Approximately 70 percent of the tussock moth infested areas that are in cattle allotments will be logged, and of this, 33 percent is expected to be available for forage production for 10 years or more.

There is expected to be a negative impact for about 2 years while logging is in progress; however, it is expected that there will be an overall gain for 10-15 years. This increase in annual value will gradually be reduced as tree crown cover is restored.

The cost assigned to these calculations include chemical application and monitoring which average $4.14 per acre. The calculated benefit per acre for the 648,677 acres of proposed treatment averages slightly more than $45/acre. The average benefit/cost ratio based on these figures is slightly higher than 10/1.

The benefit/cost for individual areas varies from 2.8/1 to 13/1. Costs per acre vary from $4.01 to $14.58. Benefits/acre range from $26.53 to $73.22.

WORKSHOP: INFORMING THE PUBLIC ABOUT FOREST ENTOMOLOGY

Moderator: J. Wayne Brewer

Participants: Russell Clausen, John Stein, Charles Minnemeyer, Nit Kirtibutr, LeRoy Kline, Richard Washburn, Fay Stoval, Doug Parker.

An increasing number of decisions on forest entomology problems are being made on a political basis. At times these decisions appear to be in direct opposition to the technical recommendations of forest entomology experts. The fact that such decisions are politically based is perhaps unfortunate, but there seems to be little possibility of altering this situation in the near future. As forest entomologists we must adapt to the "new" rules and use them to our advantage. An informed public can help us politically by applying pressure to decision making groups so that technically correct decisions are made, even if based on politics. To do this, however, we need to make greater efforts to keep the public informed about forest entomology problems, current research and possible solutions.

The workshop introduction was followed by a discussion of the various means of communication. Several approaches to public communication were mentioned, including technical papers and reports, newspaper articles, public talks and articles in popular magazines.

The workshop participants generally concluded that papers in technical journals were of little value in getting information to the public. Some participants suggested that even colleagues in the same field are often not reached by this method of communication.

It was also agreed that although newspaper articles reach a large audience, they were not entirely satisfactory as an avenue of communication because of the lack of control of the scientists over the final article. It was pointed out that information given reporters was frequently distorted, to the point that ideas were changed and the public actually misinformed. It was suggested that the problem could be resolved, in part, by insistence that the author be allowed to proofread the final draft. Some participants agreed, however, that articles should be written by the scientist, not a reporter, for best results.

Public talks were generally thought to be a good means of reaching a limited number of people. It was noted that efforts in preparing and presenting material in this way, was substantial but probably worthwhile. Some participants noted that lines of communication and cooperation initially started by such public presentations were actually more valuable than the talks themselves.

Popular articles in local or national magazines were acknowledged as a valuable means of getting information to a large number of people. Although such articles require a good deal of preparation time, the cost is frequently borne by the magazine, and high distribution means that you are communicating with a large section of the public. Local, or state, publications are especially valuable if your article concerns a localized problem.

Some participants suggested that such articles or public talks were not really a part of the federal forest entomologist's job and that other government agencies were already responsible for communications of this type. It was generally concluded, however, that any means available to forest entomology groups should be used to make the public more aware of problems and research efforts being made on those problems.

WORKSHOP: WHAT ARE THE BARK BEETLE RESEARCH NEEDS FOR ADEQUATE RESOURCE MANAGEMENT

Moderator: William F. McCambridge

Jack Bongberg made the observation several years ago that we don't seem to have made any progress in bark beetle control in the past

30 years. Fundamentally, we are still watching outbreaks develop in timber stands that have become susceptible to beetles and then making feeble attempts at chemical control only after public concern is fully aroused.

In January, 1971, an attempt was made to "see where we stand" during a Westwide Bark Beetle Research Planning Conference held at Placerville, California. Objectives were:

1. To determine the current status of knowledge on the western bark beetles,

2. To identify needs for additional research and opportunities for better coordination of research efforts within the Forest Service, with universities and with other organizations,

3. To propose alternative ways of structuring Forest Service effort on this group of insects, and

4. To devise more effective means of translating research results into action.

Objectives 1 and 2 were well covered and research priorities drawn up for bark beetles in the West as follows:

(a) Develop methods to measure impact on resources,

(b) Develop methods to measure trends,

(c) Develop techniques for suppression and regulation of populations by use of toxicants, behavioral materials (i.e., attractants, repellents), host resistance, and stand manipulation,

(d) Develop integrated strategies for pest management.

Priority (a) was avoided in this workshop because Al Rivas was moderating a concurrent workshop on cost-benefit evaluations which would be expected to touch on impact. Major emphasis was placed on measuring trend.

Any system for measuring trend should be able to determine: (1) is this the beginning? (2) which way is the beetle trend going? (3) how big will the outbreak get? Up to this point, trend methods have been developed only to answer question 2.

Present trend techniques are simplistic in that they account for beetle brood size before flight. We need to take into account the condition of the host and agents such as root rots that may effect host, or radical stand disturbances that may or may not be responsible for starting outbreaks, depending on the bark beetle

species. Cole is working on a probability test aimed at determining when the stand reaches a certain condition of risk.

Trend techniques, such as they are, are presently used for the next generation of the mountain pine beetle in ponderosa pine and in lodgepole pine, and for the spruce beetle. No methods are available for the western pine beetle, Douglas-fir beetle, or other bark beetles although Furniss is working toward that end with the Douglas-fir beetle in Region 1.

It was not entirely clear what administrators would or could do with refined trend data. Even if research could define when epidemics are starting, survey and control machinery probably could not cope with early information. Part of the problem is the diversified objectives of mixed land ownerships. There were mixed opinions that an epidemic could be stopped, even for a univoltine species if detected when just starting. It was interesting to note that it had never been tried. Furthermore, check (untreated) areas had seldom, if ever, been set aside in the west to measure effectiveness of beetle control projects. The opinion was expressed that for some beetles direct control is "no good." There would likely be general argument on this.

Fairly general agreement was held that bark beetle epidemics would continue until stands were made less susceptible to fostering beetle development. Management will constitute preventive control and can be refined by dividing forest sites into management units based on expected beetle susceptibility. However, there may be times when even managed stands would fall victim to beetle epidemics. In reply to why managed stands in the south continue to have outbreaks, it was pointed out that mixed ownerships prevented the widespread management that people imagine. In many cases existing stands are exploited, not managed. Furthermore, factors like flooding or drought or root disease can and do seriously alter a so-called managed stand and it becomes susceptible to beetle buildup. In a sense stands may be managed for people needs, but not from beetles' standpoint.

It was pretty much agreed that for some beetles to become epidemic tree growth should be fairly good even though the tree may be under stress from crowding (more or less permanent) or from other causes (permanent or temporary) such as fungi, daily moisture stress, etc. SPB nearly always maintains itself in "poor" trees (decline, lightning struck, etc.) and moves to others during epidemics. If it was meant that during epidemics the better trees are attacked, then this seems agreeable, but epidemics probably only start by buildup in weaker trees. Characteristics of such conditions are not well known and difficult to measure.

A lot could be done in resource management by fully utilizing existing knowledge while recognizing that each manager has special needs depending on his objectives and the need for special studies must be fulfilled.

In view of mixed opinions and persistent questions on the efficacy of the direct control of bark beetles, it was proposed that a thorough, formal, comprehensive review be undertaken at a subsequent WFIWC to determine if and when direct control was effective. In the face of strong objections to "formal" and "comprehensive" the proposal was withdrawn.

TERMITES AND WOOD-DESTROYING BEETLES--PROBLEMS AND RESEARCH

Speaker: Richard V. Smythe

Introduction

Because my remarks were extemporaneous and based largely on slides, it's not possible for me to reproduce the talk I presented at the 25th Annual Western Forest Insect Work Conference held in Salt Lake City, Utah, March 4-7, 1974. What follows, then, is an approximate summary of my remarks.

When we consider wood products insects, those insects that damage wood in storage and in use, we're talking about insects that affect the lives of a great many people. Curiously, despite their economic importance, some of these insects are virtually unknown and seldom seen; others, like termites, are well known and often seen.

The main reason wood products insects are so important is, naturally, because wood is so important. A substantial proportion of the wood used in this country goes into residential construction. More than one-third of all plywood and about 40 percent of all lumber is used in the construction of residential housing. It follows, therefore, that many problems with wood products insects are associated with houses.

Problems

A short series of slides was shown illustrating common construction faults which are repeated every day all across the country and which predispose houses to attack by termites, wood-destroying beetles, and wood decay fungi--attack by decay fungi is often closely related to attack by insects.

Damage.--Several slides showing unusual wood decay damage in houses were shown followed by some slides illustrating typical damage by the wood-destroying beetle, *Xyletinus peltatus* (Harris), which is the most damaging wood-destroying beetle in the Southeastern United States. Then extensive termite damage to a house which was less than 5 years old was discussed, followed by a brief discussion of the extent and cost of termite damage in the Southeast. For example, the cost of preventative and remedial treatments done to houses by commercial pest control operators in Arkansas, Georgia, Mississippi, and Tennessee in the year 1972 totaled approximately $30 million.

Unfortunately for us, termites do not confine their attack only to wood in use, they will attack almost any cellulose product and many noncellulosic products as well. A slide series was shown demonstrating the range of products termites have attacked, e.g., living trees, fabrics, polyvinyl chloride, cable sheathings, and corks in wine bottles.

Research

Our laboratory, the Wood Products Insect Laboratory, is the only laboratory in the nation solely devoted to the study of wood products insects. As such, we have a nationwide responsibility to study the biology and control of insects that damage wood. Our work with subterranean termites goes back many years, but only in the last 6 to 7 years have we mounted a serious research effort on wood-destroying beetles.

Wood-destroying beetles.--Commonly, these wood-destroying beetles are referred to as power-post beetles--a term often misleading and confusing. The main problem is that the term power-post beetles is too all inclusive as it is indiscriminately applied to beetles in five or six different families. Some of these beetles have very different habits and damage capabilities and should be controlled by different techniques. The differences between some of these beetles with respect to the type of material and the kind of wood normally damaged was then briefly discussed.

This discussion was followed by a description of the biology of *X. peltatus.* The adults are active only at night, usually in crawl spaces, and are seldom seen. In the Gulf Coast area, emergence may extend from April through September, but probably 90 percent of their emergence occurs between the last week in May and the first week of June. The adults live 3 to 4 weeks without feeding. Eggs are deposited on roughened wood surfaces such as cracks, crevices, nail holes, etc. The larvae live in the wood from 1 to 5 years or more, and it is the larvae which tunnel through the wood and cause the damage. They pupate near the surface and the emerging adult chews an exit hole in the wood surface.

Some of our research results with beetle feeding and oviposition were then discussed concluding with a comparison of the damage capability between individual beetles and individual termites. Surprisingly, individuals of X. peltatus are capable of eating much more wood than are individual subterranean termites.

Subterranean termites.--Termites are found in all 48 contiguous states, plus Hawaii. Alaska is our only termite-free state.

As previously indicated, our laboratory has conducted tests on the control of subterranean termites for many years. With the aid of a slide series some of our test techniques were then discussed. Ground-board tests consist of an area of treated soil with a 1- by 6- by 6-inch piece of susceptible pine baitwood placed on top in the center. The purpose of this test is to see whether the termites can tunnel through the treated soil and damage the test board. All vegetation and duff are removed from a 17-inch square. Water emulsions of insecticide are sprinkled very evenly over the soil surface at a rate of 1 to 4 pints per square foot. The bait board is placed in the center of the treated soil and held in place with a brick or concrete block. The duff is then replaced to restore the test site to its original appearance.

Over the years a great many chemicals have been tested for their effectiveness as soil insecticides. A number of these were discussed. An important finding here is that many chemicals which protect wood for many years against subterranean termites--for example, creosote and entachlorophenol--have an effective period in the soil of only 2 to 3 years.

The "Big Four" chemicals were then discussed. These compounds--chlordane, aldrin, dieldrin, and heptachlor--have been used worldwide for many years to protect property and products against the ravages of subterranean termites. Our tests, the oldest in the world, demonstrate 100 percent effectiveness for heptachlor after 21 years, aldrin and dieldrin for 24 years, and chlordane for 25 years.

It should be remembered that these chemicals have been tested on our experimental forest 20 miles north of Gulfport. Thus, they reflect persistence under south Mississippi's conditions and do not necessarily reflect persistence under other environmental conditions. We currently have tests in Arizona, Florida, Maryland, Missouri, Oregon, Panama Canal Zone, and South Carolina. Basically, these nationwide tests have performed very similarly to tests in south Mississippi.

Another point to keep in mind concerning our ground-board tests is that they don't indicate what happens to insecticide placed under a concrete slab. As you well know, many of our new houses, in

fact, the great majority in the Southeast, are slab-on-grade construction. Thus, the insecticides placed beneath the slab are not exposed to environmental influences such as rainfall and sunlight. Preventing this exposure significantly influences the persistence of many insecticides, so the ground-board test was modified to simulate treating under a slab. A series of slides demonstrated this technique.

A final consideration of our termite control studies is that, as you very well know, the "Big Four" chemicals--chlordane, aldrin, dieldrin, and heptachlor--are coming under increasing scrunity by the Environmental Protection Agency and other parties interested in minimizing pollution and soil contamination. Thus, we have an active screening program to attempt to identify possible substitute termiticides in the event our current chemicals are banned for use in the soil.

To date, two chemicals have shown promise--baygon, a carbamate, and dursban, an organophosphate. Both have given 100 percent control for 6 years when placed beneath a modified slab. They do not hold up as well when tested with the regular ground-board tests.

Our program of basic biological research of subterranean termites was then briefly discussed with an extensive series of slides. One of our laboratory's major research interests is the nutritional and biochemical relationship between termites and their intestinal microfauna. Although we have known for many years that these termites harbor intestinal bacteria and flagellate protozoa, no one has ever determined the exact role of these protozoa, either collectively or individually, except to demonstrate that a termite deprived of these protozoa will slowly starve.

A second major area of our basic research program is the study of wood extractives. Clearly, some woods are more highly preferred than others. In fact, some woods are relatively termite resistant. We have a rather extensive research program underway, using native hardwoods and softwoods and a large number of hardwoods imported from Central and South America. We are first determining the most termite resistant wood species, then from a select few woods we are identifying the biologically active compound or compounds responsible for conferring termite resistance. Some of our current results were demonstrated with slides.

Whenever the subject of termite feeding on wood is discussed, a host of problems and interacting factors become involved. Many of these cause considerable confusion to the general public, for example, the widely held belief that redwood or western redcedar is resistant to termite attack. Some of these "general interest" items were briefly discussed.

HISTORY AND GOALS OF THE WESTERN FOREST INSECT WORK CONFERENCE

Speaker: Richard I. Washburn

I have been charged with an impossible task: To cover in 30 minutes the history and goals of the WFIWC on this, it's silver anniversary. The proceedings alone contain over 2,000 pages and, as most of you know, much of what goes on at these annual get-togethers never gets into the proceedings.

Hopefully my presentation will stir memories or will make the less informed curious enough to ask questions of the old heads present. Obviously, My talk will be incomplete and only a brief sketch.

The WFIWC was started in 1949 by a group of 19 men with vision. It was founded because of their unselfish devotion to share; thru open, frank, and willing diffusion of knowledge, up-to-date findings, ideas, and accomplishments. Theirs was a sincere desire to advance forest entomology and entomologists.

The first meeting was held on December 7 in Portland, and lasted 3.5 hours. It was preceded by a steering committee meeting on December 6, where Hec Richmond, Paul Keen, and Phil Johnson developed a proposed constitution, and laid the ground work for the organization. The goals as set forth by the founders were: 1) to establish an opportunity for annual work meetings--NOT a learned society; 2) to prevent pressure groups from unduly interfering with the deliberations; 3) to stress informality and to encourage free and open discussion by all in attendance.

In my mind the Work Conference has remained strong through 25 years for three reasons: 1) because we believe in our charter which is to share our knowledge with our colleagues; 2) our conscientious effort to actively involve all members young and old; 3) and because we provide opportunity to really get to know each other through work and play.

Now let's look at the development of the conference through time. In the period 1949 through 1958 the meetings were held as one general session. All of us sat down together to discuss the subject at hand. For the most part the members were generalists. Sure, there were a few specialists and most of us had a special interest, but generally speaking we were all expected to work on whatever insect or insects that were currently causing problems.

These early meetings all started with a review of the current forest insect conditions in western U.S. and Canada. These Presentations often set the stage for the meeting. We would focus on one of the problems; draw from the experiences of one another; interject ideas and thoughts, digest the discussion; and go back home more confident we could handle our insect problems.

The third annual meeting held in 1951 was my first. This is my 20th. These early meetings were impressive to us young bucks. They provided opportunity to extract the ore from the gold mines of unpublished data.

It was inspiring to sit and listen to the real pioneers in our business. People like Paul Keen, Jim Evenden, Joe Chamberlain, to name a few. Most of their knowledge was derived from acute powers of observation and we marveled at the logic they used to put the picture together. Their open-minded approach made it easy for the neophyte to participate in the discussions.

In the 1951 proceedings you can find statements such as, "you can not tie the cause of insect outbreaks to one factor."

Members who attended one or more of the first three meetings, and present today are; Bill Wilford, Les Orr, Galen Trostle, Walt Cole, Bob Denton, Mal Furniss, Dave McComb, our chairman Bob Stevens, and myself.

In 1952 at Victoria membership to WFIWC was defined. "Membership shall consist of forest entomologists and others interested in the field of professional forest entomology. Members are those who pay registration fees."

Phil Johnson was Secretary-Treasurer, but he became known as the "Grand Censor". He hired three "stenos" to record the meeting action. Phil decided accuracy of the minutes should be checked with the members. Unfortunately it was rather late in the evening before Phil and the gals approached the members, and no one was in shape, or willing, to own up to what he was quoted as saying. A few weren't even willing to talk bugs with young gals that invaded their hotel rooms.

By vote of the members, no proceedings were issued for the 1953 meetings held in Moscow-Pullman. Was this a carryover of the "Grand Censor's" experience in Victoria? Most of the meeting was devoted to a discussion of the spruce budworm and its control with aerially applied chemicals.

By 1954, we had stirred the pot enough that outsiders came to see what the WFIWC was all about. Many were suspicious, critical, and doubted the conference was worthwhile. At the 1954 meeting

in Berkeley we were "honored" by the presence of the Associate Chief of U.S. Forest Service in charge of Research; Chief of Entomolgical Research, ARS; Chief of Plant Pest Control, ARS; a Director of a Forest Service Experiment Station; a Regional Forester; a Dean of a School of Forestry; and the Chief of Forest Biology Division of Canada Federal Government. They liked what they saw and from that point on gave us their support. While these people were in office we had little difficulty in getting permission to attend WFIWC. It is significant that the establishment of the ethical practices committee coincided with the visitation by the brass. More on the EPC later.

During this meeting we held a 1/2-day meeting with the Western International Forest Disease Work Conference.

The 1955 meeting in Spokane was our last winter meeting. The Douglas-fir beetle was the main subject discussed. No meeting was held in 1956.

The 1957 meeting at Calgary stands out in our history for a couple of reasons. The first "formal" paper was presented by Ron Stark, title: "Climatic Factors Affecting Insect Abundance". It proved that papers can be an effective way to stimulate discussions under our informal work conference environment.

The gavel used by our chairman was presented to the conference. It was made by Jack Whiteside. Unfortunately only 29 people attended--the low point in meeting attendance. It's a shame since this was one of the better meetings.

The 1958 meeting in Corvallis proved that even the best intentioned chairman can make mistakes. The lesson learned was never arrange to pay for the happy hour drinks by the bottle. The bartenders had only one objective--empty as many bottles as possible in the shortest period of time. Thus, the Corvallis meeting goes down in our history as the "Wild One". There was a lively and useful discussion on "Legal and Other Aspects of Spray Programmes.

The 10th meeting was held in Vancouver in 1959. Roy Shepherd's paper, "Theory Involved in Expressing Mortality", was a highlight. This paper plus the discussion that followed promoted the general acceptance in the West of the life table approach. I would suggest anyone interested in biological control would profit by reading the Vancouver proceedings. I have often wondered if our wholehearted, enthusiastic and total involvement in after hours activities is the reason Vancouver has never invited us back to their fair city.

I was co-chairman for the program and arrangements at the 1960 meeting held in Ogden. To recall this meeting is painful. To this day I cannot walk into the Ben Lomond Hotel without hiding my face. I have never returned to the restaurant where I had arranged for a banquet but where we held an orgy. Orgy as defined by Webster: An ancient ceremonial rite, characterized by ecstatic singing, dancing, and excessive indulgance in activity; a drunken revelry.

Nevertheless the technical meeting was good except where it was interrupted by bellboys delivering dog food and cabbages. The gavel and ninety oak arm chairs disappeared. Marilyn appeared in the office of the Director of INT. The theme was, "Criteria For Control Decisions". The business meeting was significant in that 1) the use of the central triangle concept was dropped in the selection of future meeting sites; 2) it was decided that meeting locations should be established two years in advance. In the proceedings of this meeting is printed the first listing of forest insect research project titles active in western U.S. and Canada.

The 12th annual meeting was held in Berkeley in 1961. The preparation and issuance of insect condition reports was discontinued. At this meeting we had displays of gadgets and illustrations of methods and techniques. There were 26 displays which proved to be an efficient way to communicate ideas. Theme of the meeting was: "The Effects of Insect Damage From Regeneration to Final Product".

In 1962 the meeting was held in Tucson. The theme was, "Insects affecting regeneration". Ken Wright was outlawed by majority vote for ever serving as future chairman of EPC.--he brought his wife to the meeting, this restricted his freedom in selecting the candidate to succeed him as chairman of EPC.

1963, Portland, Oregon:

Theme, "The Future of Forest Entomology." A quote from the proceedings, "The question is not so much how many insects we kill but how this affects the whole system." An expression of our growth and broadening outlook. You can trace much of our intellectual growth through the proceedings of the WFIWC. 1963 was the first year we had concurrent workshops.

1964 - The year of the 4 B's - Banff and Bison, Bison, Bison. The keynote address Tongues in Trees by B. Hocking was a classic. If your bag is defoliators or sucking insects go back and review the proceedings of this meeting. A song, "The Bug Men" was composed and sung by Choral Belles of Calgary. It is printed on page 66 of proceedings. Skiing, and our first try at curling.

1965 - Denver, Colorado.

Combined meeting with Central International Forest and Disease Work Conference. Theme: "New Horizons in Insect Control". Total attendance, 118 of which 78 were WFIWC members. Membership roster changed to alphabetical listing rather than by regions.

1966 - Victoria - "Climate and Insects"

J. A. Turner, a meteorologist presented a paper "Dimensions of Weather". We attempted to look into the future of bioclimatology in insect research. A panel reviewed the climatic influences on bark beetles. Graphic demonstration of micro bio-electronics. Tour of Victoria lab. Curling.

1967 - Las Vegas, Nevada

As chairman I was presented key to city and told to contact the mayor or his staff on any problems with the city. I was forced to call. The city police did not treat some of our members as welcomed guests. Theme: "The Role of Forest Entomologists in the Arts and Sciences of Forest Management." We had forest managers tell us how they viewed forest insects and forest entomologists. Excellent panel, "Communications in Forest Entomology". How about Don Lucht's paper, "Entomologist's Dilemma". Read it, you'll like it!

We had a tour of the ecological island of Charleston Mountain.

1968 - Berkeley. "Pest Management and Forest Entomology".

Program Chairman Dave Wood pulled a switch. He used prominent key outsiders as moderators of our workshops. It worked and the workshops took on a new dimension.

We toured Boggs Mt. and viewed studies of root diseases and bark beetles. No problems. We also toured wineries. Problems. As chairman, I was flooded with demands by nonentomologists to justify this tour at employers' expense. My explanation: Wine is made from grapes. Grapes grow on plants. Insects feed on plants. Entomologists study ways to minimize insect damage. It's simply a desire to see what effect the actions of entomologists have on the end product.

1969. The meeting was scheduled for Alaska, but due to travel restrictions held in Coeur d'Alene. Less than 70 people were expected. Registration at the initial business meeting was 157 and by the end of the day it had reached 170. The largest attendance recorded.

We planned a boat tour of the Lake, complete with speakers and a full load of refreshments. One week before the meeting the lake froze solid--only time in the last 50 years. Switched to bus tour of surrounding country including the mining district of Kellogg and Wallace. Jim Evenden a pioneer forest entomologist was our luncheon speaker. Under the title of "Those Were The Days" he reviewed the early history of forest entomology in the west.

A powerful panel "Microbial Control Of Forest Insects--Past, Present, and Future" was put together by Bohdan Maksymiuk. Participants: Art M. Heimpel, H. T. Huang, Irvin M. Hall, Tony Jasumback, and Benton Howard.

An integral part of the meeting was a summation and critique. A self evaluation to see where we could improve. A photo salon and gadget display was included in the program.

By vote of membership it was decided that if a registration fee had not been paid in the last two years the member's name would be dropped from the proceedings mailing list on the third year unless a fee of $5.00 was paid.

1970 - Seattle. Rick Johnsey was program chairman.

A panel, "Public Relations in Forest Protection", was a highlight. The moderator was Ben Howard and panel members were: Gerry Kelley, Public Relations Officer, USFS; Terry Cornelius, student; Herb Willison, Crown Zellerbach Corporation; and Brock Evans, Sierra Club. Who can forget the face to face confrontation of Brock Evans of Sierra Club and Bill Waters? Brock's main point: "One must talk to your audience and with your audience". We toured the Boeing 747 aircraft plant.

1971 - Glenwood Springs

Good program, mostly panels. McCambridge as program chairman had his way. One of the better panels was "Attraction of Defoliators"; moderator Mel McKnight. Flu epidemic dampened the meeting. Meeting was proceeded by ski race, dominated by the over-40 gang. The youngsters took another look at the old heads. Swimming outside in mid-winter.

Glenwood was another meeting that proved if you have an interesting program and an inviting setting, the members will come. 122 people registered.

1972 - We moved north to Edmonton. Les Safranyik and his committee put together an excellent program utilizing outside specialists in the fields of economics and environmental protection. Three concurrent workshops, "Future of our Conference". Another self evaluation showing our serious desire to continually improve our work conferences.

Who could fail to be impressed by the banquet put on by the Province of Alberta? Especially when the lights were dimmed as the pipe band marched in followed by a long line of uniformed waitresses, each holding high a baked Alaska aglow with sparklers. Another session of curling and a tour of the new laboratory. These extras are what make the conference.

1973 - Back to the warm sunshine in Tucson for our 24th annual meeting. Coffee under the palm trees and a real breath of summer for the winter-weary northerners. A stimulating meeting, flavored with an insight of some of the forest insect problems back East. The first chance for eastern and western budwormers to exchange knowledge.

Which brings us up to date. 1974 and our silver anniversary here in Salt Lake City.

The record would not be complete without mention of the many committees that have functioned so well for our conference.

The Committee on Unpublished Reports and Materials at Western Laboratories of the United States and Canada

The listings were completed in 1964 except for the Berkeley and Portland labs, and made available to members. They can, and have served well to determine what was done at the various labs.

Common Names Committee

This is your organ for proposing common names. After clearance from this committee the names are submitted to ESA. This committee has been responsible for adoption of many common names of forest insects.

Education Committee

Established in 1952. Published findings of needs for entomology training for foresters under title "Foresters Look at Forest Entomology Training" by R. W. Stark in Journal of Forestry 1962. The conference purchased copies for distribution to all universities with schools of forestry.

Foreign Translation Committee

The final report of this committee appears in proceedings of 1965 meeting.

Ethical Practices Committee

The only committee for which a member must earn his right to serve as chairman. This committee was established in 1954 out of recognized need. The purpose of the committee is to give recognition for deeds over and above that normally called for by most position descriptions. The chairman is presented a badge of honor that is handed down from one to another. This memento is an artifact from the halls of entertainment. It was once removed from the warm and inviting nuptial chamber of "Tempest Storm" the Grand Dam of burlesque. The names of the "honored" chairmen are listed at the end of this paper.

SUMMARY

The work conference has developed through the years by retaining the basic charter established in 1949. As a group we have evolved from generalists that were few in number to an era of many specialists. Our work conference programs have kept pace with change. In fact, if one looks closely the work conference has been instrumental in some of these changes. We have recognized the value of total participation, and the need to occasionally bring in outsiders to give us a different perspective. Our ranks have grown and to accommodate this growth we have gone to concurrent workshops.

We have had periodic reviews and examinations to see if we could improve our meetings to better serve our needs. Each evaluation has strengthened our faith in the original charter: That we need an opportunity to talk person to person with colleagues that share our interest in forest entomology. We have proved through the years that you can have a structure and still be informal. We have gotten to know each other through work and play.

We have marched successfully through 25 years because we have continued to keep these needs foremost in our minds. We face the future with confidence, but fully conscious that we could fail if we become complacent.

Thank you.

WESTERN FOREST INSECT WORK CONFERENCE

Ethical Practice Committee

Year	Meeting No.	Location	Chairman
1953	5	Moscow-Pullman	Jim (Bum Tittie) Kinghorn[1]
1954	6	Berkeley	Cal (Tempest) Massey[2]
1955	7	Spokane	Walt (Piano) Cole
1956	No Meeting		
1957	8	Calgary	?
1958	9	Corvallis	Ken (Wild Man) Wright
1959	10	Vancouver	Walt (Whirl Around) Cole
1960	11	Ogden	Jack (Potato King) Mitchell
1961	12	Berkeley	Russ (Nice Boy) Mitchell
1962	13	Tucson	Tom (Direct Route) Silver[3]
1963	14	Portland	Tom (High Standards) Silver
1964	15	Banff	Don (Bison-Bison) Dahlsten
1965	16	Denver	C. J. (Rolled) DeMars
1966	17	Victoria	Rob. (Who Me) Reid
1967	18	Las Vegas	Ken (Mack the Knife) Graham[4]
1968	19	Berkeley	Al (3 In a Bed) Berryman
1969	20	Coeur d'Alene	Walt (Intruder) Cole[5]
1970	21	Seattle	Russ (Laddies) Mitchell
1971	22	Glenwood Springs	Deacan Dan (Dancer) Jennings
1972	23	Edmonton	Paul (Street Lady) Buffam
1973	24	Tucson	Bob (Madam) Dolph
1974	25	Salt Lake City	No member met standards

[1]First recognition of need for committee

[2]Acquisition of badge of honor and establishment of permanent committee

[3]In 1962 Ken Wright by resolution and unanimous vote outlawed from serving as future chairman

[4]First recognition of need for separate award for fairer sex

[5]Walt Cole holds record of being elected three different times

CHRONOLOGY

WESTERN FOREST INSECT WORK CONFERENCE

Meeting	Location	Year	Officers[1]	Counselors	Attendance No.
1	Portland	Dec. '49	F. P. Keen A. J. Jaenicke		19
2[2]	Fort Collins	Dec. '50	H. A. Richmond P. C. Johnson	A. J. Jaenicke G. R. Hopping L. W. Orr	26
3	Portland	Nov. '51	H. A. Richmond P. C. Johnson	R. L. Furniss L. W. Orr G. R. Hopping	52
4	Victoria	Dec. '52	H. R. Richmond P. C. Johnson	R. L. Furniss L. W. Orr W. G. Mathers	Not listed
5[3]	Moscow-Pullman	Nov. '53	R. L. Furniss M. G. Thomson	W. G. Mathers N. D. Wygant C. B. Eaton	
6	Berkeley	Dec. '54	R. L. Furniss M. G. Thomson	W. G. Mathers N. D. Wygant C. B. Eaton	48
7	Spokane	Dec. '55	R. L. Furniss M. G. Thomson	N. D. Wygant C. B. Eaton R. W. Stark	65
		No Meeting 1956 (Meetings changed from Dec. to March)			
8	Calgary	March '57	M. G. Thomson R. L. Furniss A. D. Moore	R. W. Stark D. E. Parker C. L. Massey	29

Meeting	Location	Year	Officers[1]	Counselors	Attendance No.
9	Corvallis	Feb. '58	M. G. Thomson R. L. Furniss A. D. Moore	R. W. Stark D. E. Parker C. L. Massey	68
10	Vancouver, B.C.	Feb. '59	R. W. Stark M. G. Thomson J. M. Kinghorn	D. E. Parker C. L. Massey E. C. Clark	49
11	Ogden	March '60	R. W. Stark Dr. K. Graham J. M. Kinghorn	C. L. Massey E. C. Clark G. T. Silver	59
12	Berkeley	March '61	B. H. Wilford R. W. Stark A. E. Landgraf	G. T. Silver G. R. Struble D. O. Scott	92
13	Tucson	March '62	B. H. Wilford R. W. Stark A. E. Landgraf	G. T. Silver G. R. Struble N. E. Johnson	61
14	Portland	March '63	K. H. Wright B. H. Wilford P. W. Orr	G. R. Struble N. E. Johnson R. F. Shepherd	94
15	Banff	March '64	K. H. Wright B. H. Wilford P. W. Orr	N. E. Johnson R. F. Shepherd J. A. Schenk	63
16	Denver	March '65	J. M. Kinghorn K. H. Wright A. F. Hedlin	R. F. Shepherd J. A. Schenk F. M. Yasinski	78
17	Victoria	Feb. '66	J. M. Kinghorn K. H. Wright A. F. Hedlin	J. A. Schenk F. M. Yasinski R. E. Stevens	86
18	Las Vegas	Feb. '67	R. I. Washburn J. M. Kinghorn G. C. Trostle	F. M. Yasinski R. E. Stevens R. E. Stevenson	73
19	Berkeley	March '68	R. I. Washburn J. M. Kinghorn G. C. Trostle	R. E. Stevens R. E. Stevenson J. F. Chansler	96

20	Coeur d'Alene	March '69	E. D. A. Dyer R. I. Washburn L. H. McMullen	R. E. Stevenson J. F. Chansler P. G. Lauterbach	170
21	Seattle	March '70	E. D. A. Dyer R. I. Washburn L. H. McMullen	R. E. Stevens P. G. Lauterbach D. L. Dahlsten	114
22[4]	Glenwood Springs	March '71	D. L. Wood E. D. A. Dyer T. W. Koerber	P. G. Lauterbach D. L. Dahlsten W. E. Cole	120?
23[4]	Edmonton	March '72	D. L. Wood E. D. A. Dyer T. W. Koerber	D. L. Dahlsten W. E. Cole B. E. Wickman	92
24	Tucson	March '73	R. E. Stevens D. L. Wood M. E. McKnight	W. E. Cole B. E. Wickman W. G. H. Ives	94
25	Salt Lake City	March '74	R. E. Stevens D. L. Wood J. M. Schmid	B. E. Wickman W. G. H. Ives R. G. Cox	80

[1]First Name - Chairman, second Immediate Past Chairman, third Sec.-Treas.

[2]Note proceedings mislabeled as "First Annual Meeting"

[3]No proceedings issued by vote of members

[4]Proceedings not distributed as of this date

WORKSHOP: NEW INFORMATION ON THE BIOLOGY AND CONTROL OF THE DOUGLAS-FIR TUSSOCK MOTH

Moderator: G. Trostle

Laboratory research by the Insect Evaluation Project: Robert Lyon

Our laboratory studies begin with routine screening of candidate materials by topical application. To date, we have screened about 80 compounds in this manner. At least 20 of these are probably toxic enough and have other essential traits to qualify them as promising candidates for further study on the tussock moth. This work began in 1964 and 1965 with the development of a rearing technique on artificial diet. Our screening has also included a feeding test for those compounds which are active primarily by the stomach route.

Selected candidates of high potential are evaluated further using spray chamber bioassay techniques and commercial formulations or experimental formulations that are being developed for field tests. Three of the areas of study are outlined below: susceptibility of different populations of tussock moth (there is some current speculation that we are dealing with more than one species or variety), toxicity by instar, and residual toxicity on foliage.

Two populations were tested in 1973, one from California and the other from Oregon. There were no significant differences in the response of larvae treated with pyrethrins, bioethanomethrin, mexacarbate (Zectran), phoxim, and DDT. California insects were significantly more susceptible to carbaryl and methoxychlor. The difference at LD50, however, was only about two-fold. From the standpoint of relative toxicant susceptibility of those populations tested thus far, there are no firm indications that we are dealing with different tussock moth species or varieties. We are continuing this research in 1974 with populations from Idaho, Montana, and Oregon. The population in California collapsed so we cannot include these.

The toxicity of bioethanomethrin, pyrethrins, resmethrin, mexacarbate, carbaryl, trichlorfon, and DDT have been tested on 2nd, 4th, and 6th instar larvae (carbaryl and trichlorfon were tested on 4th and 6th instars only). The purpose of this research was to provide information on the effect of instar on response to insecticides as essential data in the design of field tests and timing of spray application. With one exception, the results showed the expected trend of increasing tolerance with advancing instar. The 2nd instar was most susceptible. The 4th instar generally required a 2-3x increase in dosage for the same mortality effects, and the 6th instar required a further increase of about

2x in dosage over the 4th instar. Dosage here refers to deposit in the spray chamber as measured by colorimetric analysis of sprays containing a dye tracer.

Residual life is being studied by application of the most promising candidates to potted trees and exposing them to weathering outdoors. After different lengths of exposure, trees are returned to the laboratory where the residual toxicity is measured by caging tussock moth larvae on them for a 5-day feeding period. To date, DDT and carbaryl have shown the longest residual, in excess of two months. Trichlorfon showed a residual of about 2 weeks. Mexacarbate was toxic for 2-3 days and the pyrethroids for less than 1 day. We plan to test other chemicals and include studies on the effect of tree species on residual life.

Although most of the materials we have tested are conventional insecticides, whose main action is acute mortality and primary lesion is cholinesterase inhibition, we are also evaluating chemicals which act on biochemical or physiological systems unique to insects or Arthropods. One example of this is TH-6040 or Largon which has growth regulating properties superficially similar to, but chemically unlike the juvenile hormone mimics. Largon acts only by feeding and affects the moulting process. This gives it a highly desirable selective action since it is innocuous to larvae such as predators that do not feed on the treated foliage, and non-toxic to adults that do not moult, such as parasites that may be flying during spray application. It has low activity on higher organisms and has been shown not to magnify in the food chain in Metcalf's "model ecosystem". The mode of action of Largon is related to cuticle formation. It appears to promote chitinase formation and blocks the synthesis of chitin. We are studying its metabolic pathway and degradation in the insect.

As a final note, since we probably cannot depend on natural populations of tussock moth for our supply of test insects in future years, we are developing a laboratory colony of this insect so that we can continue our research after wild populations collapse.

Needed improvements in the field testing of insecticides:
Carroll B. Williams, Jr.

I believe there are several things we need to do immediately to improve our field testing of insecticides:

1. We can use the experimental designs appropriate for the

various published statistical tests. The designs must provide for adequate population sampling in order to detect all real treatment differences.

2. We must obtain better application of insecticides on target areas (and target insects). We must use competent, experienced pilots under good guidance and apply the materials with the most efficient equipment under suitable meteorological conditions.

3. We need to learn more about the physical and chemical properties of the candidate insecticides in various formulations. This knowledge allows us to use the different insecticides in ways that would maximize their field effectiveness against the target pest populations and minimize any negative impact on the environment.

4. We need to learn more about the biology and ecology of the target pest populations to determine their periods of most susceptibility and vulnerability to an insecticide application. Eventually we have to know how insecticide applications affect generation survival in the treated and subsequent generations.

5. We need more information on how insecticide applications can be timed to reduce the severity of the target pest's impact on the resources we're trying to protect.

The experimental designs of recent field tests of insecticides against forest defoliating insect pests have included adequate treatment replication and have also satisfied the conditions for analyses of variance and other statistical tests. The resulting data cover much of the variability that occurs in target pest population densities, treatment coverage and effects. The data also has better statistical reliability than those from earlier tests. The 1972 Zectran tests and the 1973 Cooperative Field Tests against the Douglas-fir tussock moth (DFTM) in Oregon, Washington, and Idaho and the 1973 Pine Butterfly test in Montana are recent examples of the better designed insecticide field experiments. The population data from these tests have strong statistical reliability.

Unfortunately, we still have two major problems to solve in the conduct and assessment of field tests. We have to improve our aerial application techniques in order to insure good delivery of the insecticides to the target insect population. We also have to make sure that the data we obtain accurately reflects the biological parameters we are examining. These problems are usually present in all field tests. The latter problem can be reduced by hiring

hard working, highly motivated personnel for field crews and giving them good training and close supervision in the field.

The problem of aerial application and delivery of the insecticides to the target insect was the major problem in the 1973 Insecticide Tests against the Douglas-fir tussock moth in Oregon. As a result, we could say very little of a definite nature about the field effectiveness of the chemicals used in these tests.

There are many factors that influence effective aerial application of insecticides. A list of these factors would include application equipment and techniques, climatic factors of temperature, rain, and sunlight, wind turbulence above and within the forest canopy, spray physics, and forest stand density and structure. In addition, effective application of an insecticide is influenced by the physical and temporal exposure of the target insect, and its population densities in various habitats, stand structures and forest types. Most of the factors or variables listed here are not controllable, some are not even measurable, but they all influence the probability of contact of an aerially borne insecticide droplet with a target insect.

The probability of contact between the insecticide droplets and the target insect is also partly dependent upon the persistence and toxicity of the chemical itself. Much of the information on the persistence and toxicity and other chemical and physical properties of the insecticide formulations comes from various chemical companies and their tests and also from our laboratory tests.

Although the laboratory studies of the Insecticide Evaluation Project were well covered by Bob Lyon, I would like to emphasize some of them again. In the past, a large proportion of our laboratory work was the screening studies of candidate insecticides dissolved in acetone topically applied to laboratory insects. These studies were often little or no help to subsequent field tests. Recently, spray chamber studies using commercial or experimental formulations of insecticides with high potential have provided good information on toxicities that can be relevant in the field tests. The persistence of these formulations are also evaluated using caged insects on potted trees. This work can be very important in helping to determine field dosages and effective use of these chemicals against the target pest.

Persistent and non-persistent insecticide formulations have different requirements in regards to spray droplet sizes and in application and treatment strategies for effective control. Practically all the field effectiveness of the short-lived insecticide is dependent upon impingement of the spray droplet upon the target insect. Target impingement is a function of target size and droplet size. To

increase droplet impingement requires putting most or all of the spray volume into the most effective portion of the droplet spectrum for target impingement and delivering them to the exposed target insect. Data from past field experiments on western budworm populations showed that spray droplets below 50 microns in size caused over 95 percent of the mortality. The problem is getting these droplets down to the target insects. Obviously good aerial application and high spray coverage is very important to the field success of non-persistent insecticides. In addition, the total target pest population must be exposed.

The poor results of the bioethanomethrin treated plots in the 1973 tests can partly be explained by poor timing of the application and poor coverage. A non-persistent material with an active insecticidal life of a day or less was applied against a Douglas-fir tussock moth population that had not completed egg hatch. Therefore, the total population was not exposed to the insecticide. This treatment strategy or timing of the application mitigated against high tussock moth mortality which is the most effective use of bioethanomethrin.

In contrast to a non-persistent insecticide like bioethanomethrin, the field effectiveness of the more persistent materials like DDT and carbaryl is greatly aided by their environmentally persistent properties. Good application coverage and an exposed target population are also important for high field effectiveness of these insecticides but not nearly to the extent as is necessary for the short-lived materials. However, since DDT and carbaryl are aided by persistence there can be a much greater use made of the entire droplet spectrum and a low VMD is not as critical. Most of the exposed larvae would be killed by impingement of the small droplets (only a few by impingement of large droplets). Insects missed by the spray droplets or insects that hatched after the application would still be vulnerable to contaminated foliage resulting mainly from the larger droplets. Since the persistence or the residual insecticidal activity of the droplets of the materials is partly dependent on amount of residue, the larger droplets in this case make significant contribution to the field effectiveness of persistent materials.

Boyd Wickman and Dick Mason will describe some of their studies on Douglas-fir tussock moth life tables which list the mortality factors and their influence on generation survival. I'll end my presentation by emphasizing that scientists conducting field tests must work closely with those studying the population dynamics of the target pest populations to determine how various insecticide treatments interact with other mortality factors to affect generation survival of the target pest. This information and also impact data are essential in any pest management program that uses insecticides.

I believe that improvements in the various areas I've mentioned in this presentation are feasible and can be accomplished now. If we seriously consider and make these suggested improvements, I'm confident that insecticides will be used much more intelligently and successfully in the management of some of our forest insect pests.

Field tests of a nucleopolyhedrosis virus and *Bacillus thuringiensis* against Douglas-fir tussock moth: Milton Stelzer

Studies to determine the efficacy of applications of a nucleopolyhedrosis virus (NPV) and *Bacillus thuringiensis* (Bt) by helicopter against the Douglas-fir tussock moth were conducted in northeast Oregon during 1973. Each of 6 treatments and an untreated control were replicated 3 times on plots of 20 acres in size. Reduction in population density were compared for the various treatments at 21 days and 35 days after spraying. Defoliation estimates were recorded in October. Excellent control, with population reduction that exceeded 95% at 35 days, was obtained with applications of the NVP at dosages of 100 billion and at 1 trillion polyhedra per acre. The virus treatments were formulated in 25% molasses[1/] and applied at a rate of 2 gpa. Applications of Bt[2/] at a dosage of 7.25 billion international units (IU) of activity per acre formulated in 25% molasses were equally effective as the NPV. All of these treatments also provided excellent foliage protection with estimated defoliation levels below 25%. In contrast, Bt formulated in Bio-Film (a commercial spray additive) failed to reduce larval densities to a satisfactory level or to provide adequate foliage protection.

Pilot tests of NPV at 100 billion polyhedra per acre and Bt at 7.26 billion IU per acre are planned for 1974. These tests should provide the efficacy data required for registration of either or both treatments against the Douglas-fir tussock moth.

1/ Cargills Insecticide Base, (Cargill Co., Minneapolis, Minn.)

2/ Dipel, Abbott Lab., North Chicago, Illinois

Tussock moth population dynamics studies in summer of 1973: Richard Mason

Tussock moth population studies were conducted in four classes of previous defoliation in northeastern Oregon. Analyses of survivorship showed that larval survival was lowest in areas of heaviest defoliation and highest in areas of no previous defoliation. But survivorship by defoliation class alone did not tell the whole story because of wide variation of survivorship within a single class of previous defoliation. We found that much of this variation was associated with the species composition of a stand. That is mixed stands of Douglas-fir and grand fir had a significantly higher survivorship of larvae than pure stands of grand fir regardless of previous defoliation intensity.

Studies of foliage consumption by Douglas-fir tussock moth in the summer of 1973: Boyd Wickman

Branch samples were taken from each population sample at each sampling period and weighed in the field to determine weight of foliage loss through the feeding season. The results were presented in a series of curves that seemed to substantiate the population studies. That is defoliation was related to stand composition in general and specifically to host species even within a mixed stand. The heaviest defoliation occurred in mixed grand fir/Douglas-fir stands with no previous defoliation (Class IV areas). Defoliation by species showed the following decreasing relationship: Douglas-fir - grand fir (in mixed stands) - grand fir (in pure stands).

Questions from the floor brought out that in different areas on different host species this same defoliater reacts differently. For example, in California and Nevada in mixed white fir and Douglas-fir stands the larvae prefer the white fir.

Effects of host foliage on the Douglas-fir tussock moth: Roy Beckwith

The effects of host foliage upon the tussock moth were investigated in the laboratory during 1973. The Blue Mountain infestation near La Grande, Oregon was the source of the material. Foliage was

obtained from the top and bottom thirds of the crowns of grand fir, Abies grandis, subalpine fir, Abies lasiocarpa, and Douglas-fir, Pseudotsuga menziesii. One-half the population was denied 1973 foliage (stress) following the molt into the third instar. Individual records were kept on larval mortality, larval development time, number of instars, frass production, pupal weight, total number of eggs and feeding behavior.

The tree species and stress factor were highly significant for most measurements. Larval mortality occurred following the removal of all new foliage; the effect was most pronounced on subalpine fir. Eliminating the new growth also resulted in longer development time, greater frass production, greater number of instars, smaller larvae, lighter pupae and reduced egg production. If given a choice, larvae fed only on the new growth indicating that old growth is only utilized under stress brought on by population density. Extensive feeding upon old growth probably heralds the decline of the infestation. Larvae appear to adapt to the old growth of Douglas-fir faster than the other two species. It is doubtful that tussock moth population would build up to outbreak status in pure stands of subalpine fir.

WORKSHOP: ASSESSING HOST RESISTANCE AND SUSCEPTIBILITY TO ATTACK BY BARK BEETLES

Moderator: Richard Smith

The stage might have been set for the workshop by yesterday's workshop on "Research needs for bark beetle control" when some doubts were expressed about the efficacy of direct control. Those doubts fell into three groups; direct control (1) does not work, (2) does not work all the time, and (3) does not last for extended periods when it does work. An alternative to direct control is indirect control which is largely centered on the host as a tree and/or stand. Thus the question of "assessing host resistance and susceptibility to attack by bark beetles" was appropriate.

It was first proposed that prior to discussing "how to assess resistance and susceptibility" it would be proper to determine if such phenomena exist. To answer this and as an introduction to the discussion, a series of brief statements was selected from the literature to illustrate that progress has been slow over the past 50 years in demonstrating resistance and susceptibility; statements made 50 years ago were not dissimilar from those made today. Most statements had the central theme that host condition

was largely responsible for oscillations in bark beetle populations, that population levels were maintained by susceptible host material and that without a continued supply of such trees, the population declined in the face of an abundance of resistant host material. However, it was noted that many published statements used such terms as "generally recognized" or "commonly accepted" without much supportive data. This brief selected scan of the literature generally supported the contention that a resistance-susceptible phenomenon exists in bark beetle-host relationships and a discussion on the subject was valid. However, it was noted that this phenomenon may not be as strong in some beetle-host relationships as in others.

At the outset of the discussion two precautions were noted:

1. That care be taken to identify a particular species with statements on resistance and susceptibility, i.e., that general statements cannot be made about all bark beetles on the bases of limited information on one. Even specific information about a beetle on one host might not be generalized to other host species of that bark beetle (Cole).

2. That care be taken to distinguish between two types of resistance as follows (Safranyiak):

   (a) That in which beetles show a decided non-preference for individual trees of its host.

   (b) That in which a host tree is unsuccessfully attacked.

The condition in 2a could not be classed as non-existent but could be classed as difficult to determine since "chance miss" and "limited beetle population" could explain the presence of unattacked trees even in areas of high beetle populations.

Slides were shown of mountain pine beetles in ponderosa pine in Colorado. Group kills extended for many acres and hundreds of trees; but a rare green tree could be seen well inside the boundary of the "dead" block of trees. Such trees were either unattacked or only lightly attacked. It would be difficult to envision "escape" as an explanation. Lack of attraction and the presence of some repellent characteristic were offered as explanations (McCambridge).

The condition in 2b was illustrated by mountain pine beetle in second growth ponderosa pine in California where trees survived heavy attacks. In the early o.e.p. work by Vite, two-thirds of the attacked trees survived the first season and one-third the

second season (Smith).

The major portion of the workshop then centered on the topic of resin and resistance. (This may have been an unfortunate development since some participants had come prepared to talk about stand parameters such as site, density, composition, structure, and about other tree parameters such as growth, moisture condition, phloem, etc. However, there was a strong voice by some participants for resin.)

Differences between primary and secondary resin systems were discussed.

1. The secondary or traumatic system functions in true fir against fir engraver, there being no primary system in *Abies.* The speed of development of the traumatic resin system determines resistance; quick development prevents gallery elongations and oviposition; slow development permits elongation, oviposition, and possible brood development. The speed of formation of the secondary system is a reflection of the tree's physiology at the time (Berryman).

2. The primary resin system is present in pine, spruce, larch and Douglas-fir and appears to function in resistance. The secondary resin system may also develop in these four genera but it is difficult to assess its importance. There seems to be no qualitative difference between the two systems in a tree. Thus the secondary system could augment the primary system quantitatively; and the secondary system could be the deciding factor in resistance (Smith).

There are problems in measuring resin quantity; pressure, duration of flow, amount of flow, and rate of flow have been used. The latter, called oleoresin exudation flow, was found by Mason to increase with improved soil moisture and with stand improvement activities.

Data were presented to show that treatment of Douglas-fir trees immediately after felling influenced the incidence of attack and suitability of brood development of *Pseudohylesinus.* Water conditions were the suggested cause (Stoszek).

The role of micro-organisms in the development of brood was discussed. A general symbiotic relationship exists, particularly for micro-organisms carried in the mycangium. (This topic will probably be expanded in the joint meeting with pathologists.) The generally greater susceptibility of loblolly pine to southern pine beetle might be attributed to less viscous resin and, when under stress, slower rate of crystillization. The resin of slash and longleaf

pine, generally considered more resistant than loblolly, has greater viscosity and rate of flow. The importance of these physical attributes of resin has not been fully resolved (Barras).

In fumigant toxicity tests with resin, non-host resin caused greater mortality and greater feeding inhibition to adult beetles than host resin. In tests using irreversible stress, within-host resistance was directly associated with resin quantity and resin quality and inversely associated with beetle numbers (Smith).

In opposition to the evidence associating resin with resistance, the view was expressed that the parallel evolution of plant and insect would suggest the ability of a beetle to tolerate resin of its host.

It was also noted the beetle orientation is a complex mechanism with chemicals playing a dual role in both host selection and resistance.

WORKSHOP: INSECT-HOST RELATIONSHIPS

Moderator: Les Safranyik

The workshop was opened by a brief introduction to the subject and an outline of topics for discussion. Host plant-phytophagous insect interrelations are the result of a long and continuing evolutionary process the manifestations of which are the development of defense mechanisms by plants and adaptations by the insects to counteract these mechanisms. Accordingly, two closely related aspects of host plant-insect interrelations are recognized: (a) host plant selection and (b) host resistance to insect attack. Food plant selection is related to susceptibility of plants to insects in the sense that selection is equivalent to food plant acceptance. On the other hand, selection will not happen unless at least some plants are rejected. This reasoning leads to the connection between food plant selection and insect resistance in plants. In the context of food plant selection only the non-preference type of resistance is of concern not the other types. However, antibiosis is thought to play an evolutionary role in this process.

The workshop dealt only with the host plant selection aspect of plant-insect relations because host resistance was the subject of an earlier workshop. Specifically, the interactions between stand structure and development and bark beetle survival were discussed with reference to the following aspects:

(a) Host selection and specificity; examination of Hopkins' host selection principle;

(b) Host finding;

(c) Beetle activity in relation to stand structure and development.

(a) Host selection and specificity: Gene Amman reviewed host selection by the mountain pine beetle in mixed lodgepole and white-bark pine stands. In one of the two situations described, the beetle attacked a disproportionately higher percentage of lodgepole than whitebark pine in the affected diameter classes. In the other situation, the infestation failed to spread from a predominantly whitebark pine stand to the adjacent mature lodgepole pine stand. These observations suggested that mountain pine beetle, at least in some situations, prefers to attack the pine species in which it completed its development. The variability of attack density, beetle size and sex ratio of mountain pine beetles following forced attacks on four species of pines was offered to show that the beetles from one host could readily complete development in other pine hosts but that there was some manifestation of beetle quality depending upon host. Amman suggested that the beetle may get cues from the host tree during development that will direct it to a host of the same species.

In the following discussion, several examples were cited which contradicted the existence of host selection as defined by Hopkins' principle. Mountain pine beetle was observed to attack Scot's, ponderosa and Austrian pines in the same area (McCambridge). Outbreaks of this beetle usually spread up-slope in lodgepole types and then spread into whitebark pine stands at the higher elevations (Klein). Dave Woods' experiments with *Ips* sp. indicated that the beetles did not show a preference when subjected to a log cafeteria although they were reared on a single species of host for over 20 generations (Furniss). Since beetle size and sex ratio are known to vary even in a single infested tree (Safranyik), the variability of these factors generally is an expression of the suitability of the beetle's environment during development. Therefore, one has to be careful in attaching a significance to the variability of insect size and sex ratio with regards to their role in host selection. The general feeling of the participants was that there is little evidence to support Hopkins' Host Selection Principle as originally stated. However, Baker, Amman, and Trostle's observations indicate that the Principle may be operating at a certain population level. Had the principle been entirely applicable, speciation according to host species infested probably would have occurred by now (Amman).

(b) Host finding: Most of the discussion was on the following question: Is there evidence for pre-landing recognition of suitable

storage and retrieval of data on forest insect conditions in Canada.

Following the discussion, Wayne Bousfield demonstrated the use of an Execuport Terminal, and Frank Barrett, Region 4 Engineering, demonstrated a WANG 720C Calculator with 702 Output Writer and 710 Disk Drive for data storage. The moderator, Chuck Minnemeyer, and Nick Crookston, Region 4, each ran a program on the WANG 720C to demonstrate pest management applications of this system. Frank Barrett spoke about the exchange service he can provide for WANG programmers and encouraged those who desire programs, or wish to contribute to his program library, to contact him in Ogden, Utah.

WORKSHOP: ESTIMATING DAMAGE CAUSED BY FOREST INSECTS

Moderator: Lawrence Stipe

The moderator opened the session by presenting a brief summary of a western spruce budworm damage survey conducted on the Salmon National Forest, Idaho. This survey was initiated in 1971 in an area of once heavy defoliation and several years of chemical treatment. The basic objectives were to measure the amount of mortality and top kill following a large budworm outbreak and to determine how best to detect and measure resultant growth loss. Cruise areas were selected in stands which had experienced several years of moderate to heavy defoliation.

Tree Mortality - Dead Douglas-fir trees were recorded on variable plots (B.A.F. 20) spaced 10 chains apart. Only trees 6 inches and above were recorded. Average mortality was 0.6 trees per acre by budworm and other causes. Dead trees without bark beetle galleries could not be classified as to cause of death. We did assume, however, that budworm was the major cause. Total mortality was 4.4 percent of the stand. Timber inventory data collected in 1962 for commercial Douglas-fir stands on the Salmon National Forest showed there were 4.7 dead Douglas-fir per acre.

A question was asked about the possibility that those trees killed by bark beetles may have been attacked because they were weakened by budworm defoliation. In Colorado, much of the beetle-caused mortality was due to the Douglas-fir beetle moving in after heavy defoliation. Since bark beetle activity was very light during this period, it is felt this was not the case on the Salmon National Forest.

Growth Loss - Growth loss data were collected from disc and core

samples. Initially, disc samples were taken from trees in areas of past defoliation at DBH and 4 discs at 7 foot intervals from the top of the tree. The top disc sample usually represented about 15-20 years growth. Contrary to what was expected, the reduction in radial increment was coincident throughout the tree. As predicted, the growth rate decreased from the top of the tree to DBH. Subsequently, core samples taken at DBH were substituted in place of the disc samples. No volume loss estimates were made.

A question arose about how the intrinsic growth pattern presented by Duff and Nolan would affect measurements in the upper crown. Most of the top disc samples were older than 15 years and would not be influenced by this intrinsic pattern.

Further, a note was made that before radial growth loss could be interpreted in terms of volume loss, a complete stem analysis was essential. Since ocular estimates of tree height caused problems, it was suggested that height could be determined using growth and diameter data. Region 1 representatives explained their system of using height, the last 5 years growth and the previous 5 years growth to measure effects of defoliation on growth. By comparing the last 5 years growth with that calculated, one can determine volume loss due to defoliation.

During collection of disc samples, terminal growth measurements were recorded. When compared with growth in the top disc, similar growth trends were found. This included reduction in terminal extension following budworm defoliation.

The Moscow lab reported finding similar growth trends between radial growth and lateral growth back about 7 years.

Top Kill: Top kill was recorded on the same variable plots as mentioned earlier. There were 7.2 trees per acre with dead tops. Length of the dead top was visually estimated and varied up to 15 feet. Diameter of the dead top was not recorded. Some top damage may have been overlooked. When laterals took over, it was difficult to discern any damage except in the most extreme cases.

A summary of the stand composition of the nine cruise areas on the Salmon N.F. follows:

	Trees/Acre	Percent
Live Douglas-fir	93.5	47.8
Dead Top	7.2	3.7
SBW Kill	8.1	4.1
Bark Beetle Kill	0.6	0.3
Live Non-Host	86.2	44.1

There was general agreement that heart rot was the major concern in relation to top kill. Two views were expressed concerning the degree of damage necessary to introduce rot fungi. One felt a 4-inch diameter was required while the other view was that any time the heart wood was exposed rot fungi could enter.

No correlation was made between tree diameter and dead tops.

Core Measurements: All increment measurements were made using a micrometer scale in the eyepiece of a stereo microscope. Increment growth was recorded by hand and converted to mm by desk top calculator. It was recommended that when extensive core analyses were necessary, an automatic measuring and recording device would be extremely time saving and provide better precision.

Automatic recording units are available from the Adomex Company. The unit consists of a microscope with a fine traversing stage and a digitizer which can be connected to an adding machine or a teletype. These units cost approximately $1,500.

Dick Washburn explained the X-ray technique used in the Moscow lab. The X-ray plates are fed through densitometer from which a graph of increment and year counts is obtained. He is also working toward the differentiation of cell density using the X-ray densitometer technique. Changes in cell density seem to occur before changes in radial growth. X-rays of long cores produced parallax problems.

Budworm defoliation and resultant damage have not caused major changes in timber management practices in Region 4. However, in Region 1 several forests have been unable to collect Douglas-fir seed for several years. Region 1 has also experienced greater top kill and tree mortality than Region 4.

Carroll Williams suggested losses can only be based on the actual volumes harvested from treated and untreated stands. Data on the Flat Head Indian Reservation show a reduction of approximately 9,000 bd. ft. per acre. Large economic losses have occurred due to defoliation in Christmas tree areas. Land managers must set the values upon which damage appraisal is based.

It is important to realize that every tree that dies or is damaged, especially those in the understory, cannot be considered a loss. Depending on stand species, composition, stocking, age, etc., it is very difficult to place a value on understory trees. In fact, insect damage may actually do thinning which is beneficial to the stand and which management would have been unable to do for lack of funds.

Many of the studies conducted are so limited in scope that their

results may be questioned. A more valid approach would be to enlist the assistance of plant physiologists and pathologists. Problems of job priorities and financing must be overcome before progress can be made. Recently, however, the team approach is becoming more popular and it should produce more meaningful results.

Sampling Techniques: The sampling procedures in use today in Region 4 are the results of a cruise study conducted by Doug Parker. Lodgepole pine mortality was measured on a 160-acre tract using 4 cruise methods - variable plot with a 5 and 10 BAF, 1/10 acre fixed radius and 1/2 x 10 chain strip plots. The results of each method were compared to a 100 percent tree tally. Results of the complete tally were 30.5 dead lodgepole pine per acre.

Comparing the four sampling methods, the following results were obtained:

1. Sample means varied from 28.2 to 32.5 trees per acre.

2. Strip plots had the lowest between plot variation.

3. Strip plots had the shortest sampling time per tree.

4. Strip plots had the highest average number of trees per plot.

5. Diameter distribution on the strip plots was closest to the actual.

6. Shortest sampling time per plot was with the 10 BAF variable plots.

The conclusion was that the 1/2 x 10 chain strip plot method would give the best estimate of mortality. Green stand data are collected on variable plots placed at the end of each strip plot.

Don Curtis described the sampling system used by Region 6 for tussock moth damage surveys. It consists of variable plots using two BAF's. A 10 BAF is used to record trees smaller than 10 inches DBH and a 20 factor is used to record trees larger than 10 inches. Each circular plot represents one acre and has four prism points.

WORKSHOP: ENHANCING CAREER OPPORTUNITIES FOR TECHNICIANS

Moderator: George H. Starr

Technicians assist professional foresters and researchers by

performing technical work in the management, conservation, development, utilization, protection and research pertaining to forest resources. Usually in this capacity a college degree is not required. Potential promotion is evaluated on ability for higher performance and acceptance of responsibility in a specific discipline. However, technicians in the U.S. Forest Service are rarely promoted beyond the GS-9 level, and there does not appear to be any trend toward providing opportunities in the near future.

The workshop participants had the following recommendations:

1. Provide an avenue which would enable technicians to obtain the education needed to qualify for professional positions.

2. Provide opportunities for technicians to develop new skills and increase responsibilities for grade advancement in the technician series.

3. Provide technicians, especially women, opportunities to attend professional meetings.

4. Enable technicians to undertake new and interesting work assignments for job enhancement.

MINUTES OF THE FINAL BUSINESS MEETING

March 7, 1974

The meeting was called to order at 10:20 a.m. in the Royal Room of the Royal Inn in Salt Lake City, Utah, by Chairman Stevens.

Minutes of the initial business meeting were read and approved.

The treasurer reported the following income and expenses:

Treasurer's Report - 1974 Meeting - Salt Lake City

Income:

Registration		
Regular members	- 75 at $5/person	$ 375.00
Student members	- 5 at $1/person	5.00
Bus trip	- 34 people at $2/person	68.00
	Total	$ 448.00

Expenses:

Bus trip		73.75
Meeting rooms		no charge
Hotel restaurant services		160.13
Gift for secretary		4.00
	Total	$ 237.88
Addition to treasury		$ 210.12*

*Cost of publishing the 1974 proceedings not known. Based on cost of 1973 proceedings, 1974 cost will exceed 1974 revenue (addition to treasury) and thereby cause a decrease in treasury.

The 1971-72 proceedings were discussed. Trostle moved the 1971-72 proceedings be combined into one volume. McCambridge seconded. Discussion followed. Washburn favored keeping the volumes separate. Johnsey questioned the speed of publication for one versus separate volumes. Ives suggested that only the cost of binding would be saved by publishing one volume. The motion carried.

Chairman Ives reported for the Common Names Committee that no new proposals were received. He requested members to submit proposals.

Interim Chairman Cole of the Ethical Practices Committee reviewed the list of candidates but concluded that none of the candidates met the high qualifications required for this office.

1975 Meeting -- Swain reported that no specific location for the 1975 meeting had been selected. Program topics were solicited. Safranyik reported that Stu Whitney would accept as co-chairman for the WIFDWC but tradition required the chairman to be from the area of the conference.

1976 Meeting -- Wickman proposed a vote on the location of the 1975 meeting. McComb moved Portland be selected, seconded. Portland accepted by near unanimous vote (except for Washburn).

Wilford voiced concern that some past members were not receiving notification of the annual meeting. He moved that it be resolved that:

1. A member of the Western Forest Insect Work Conference be as stated in the by-laws of the conference;

2. A full membership list be prepared based on the membership lists included in the proceedings of past meetings of the conference; each member's name and mailing address be placed on this list; and the list be made available to the membership;

3. The membership list be up-dated each year, by

    a. adding the name and address of each new member,

    b. deleting the name of each member that so requests,

    c. deleting the name of each deceased member;

4. Each member be sent an announcement of and invitation to each and every conference meeting.

Discussion followed. Barras said members in the south would like to receive notices of the meeting and he favored the proposal. Trostle questioned who was to be included on the list. Cole favored the proposal but added that if a member did not want to receive announcements, he so reply, and that a postcard be included with the first notice for this purpose. Washburn moved the proposal be adopted as stated. Seconded.

Discussion again followed.

Laut questioned section one of the proposal. Stevens read the article of the constitution dealing with the membership list.

Dyer questioned whether the proposal was to create a separate mailing list. Browne stated that the constitution now defines official members and members. Thus, Wilford's proposal had no conflict with the official membership list but would mean the creation of another list. Dyer also suggested an asterisk be inserted beside the name of a member attending the 1974 meeting on the 1974 official members list--a procedure dropped in 1973. Frye noted that the 1973 membership list included everyone on the mailing list.

Trostle suggested that the proposal should be amended to distinguish between official members and members. Subsequent discussion seemed to indicate that the constitution provided this distinction.

Ollieu thought the mailing list would continually expand and thereby create mailing problems. Stevens said the past proposal which limited an official member's membership to 3 years was created because of this problem. Wilford thought the problem was exaggerated and the work load would not be that great. Cole proposed a postcard be included with the first notice of the meeting. The postcard would be marked:

yes = included on the list

no = name removed from the mailing list.
if no answer within a reasonable time, then not included.

The proposal was brought to a vote and passed unanimously.

Trostle quoted from a letter from Ralph Hall on the subject of Keen's history of forest entomology. No one was aware that there was an effort to continue Keen's early work.

Safranyik asked about the revision of "Insect Enemies of Western Forests." Stevens noted the book was scheduled to go to the printers in 1975 and be published in 1976. Wickman stated that the bibliography would be available by June-July of 1974 for research laboratories. Acciavatti asked if the bibliography would be continually updated. Wickman suggested contacting Val Carolin.

Maksymiuk moved the conference praise Washburn for his presentation of the history of the WFIWC. Seconded. Passed unanimously.

Stevens requested that summaries of the workshops be submitted by April 1.

Johnsey presented the following list of candidates for the next officers:

President	Galen Trostle
Secy.-Treas.	Gene Amman
Councilor	Les Safranyik

Wilford moved to close the nominations. Washburn seconded. Passed unanimously.

Trostle took over as chairman for Stevens and moved for special recognition for:

1. Past officers
2. McKnight for his efficient publication of the 1973 proceedings.
3. Local program committee and their program.

Parker announced a presentation on the use of dried flowers would be open to all interested members in the Jewel Room.

Comments and criticism of the 1974 conference arose. Maksymiuk called for improvement of the workshops. Parker explained that the local committee had solicited suggestions for workshops, compiled a list from these suggestions and then picked those they judged to be the best. Washburn (as a past member of a program review committee) noted that the 1972 program review committee's suggestions were to be presented in the proceedings of the Edmonton meeting (1972 WFIWC). Stevens declared that the workshop chairmen should run their sessions as they choose, and saw no serious complications in this year's program. Johnsey suggested a one-day symposium on certain subjects might be added and scheduled for the day after the conference so that those desiring to participate could stay and attend. Smith suggested the conference consider holding a special review of certain topics wherein attending members would do substantial review on the subject prior to the meeting.

Swain solicited suggestions for the 1975 meeting and Trostle recommended the members contact Swain after the meeting since it was running late.

Maksymiuk wondered if there should be a general theme for the 1975 meeting. Dyer replied that the selection of a theme was the prerogative of the program chairman.

There being no other business the meeting was adjourned at 11:40 a.m.

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